SCIENCE

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*THE MAMMALIAN FAUNA OF THE SANTA CRUZ BEDS OF PATAGONIA.**

THE magnificent collections of vertebrate fossils brought back from Patagonia by Messrs. Hatcher and Peterson are still very largely in the rough state. The work of cleaning and preparing the specimens is proceeding steadily and satisfactorily, but is necessarily slow, and the preparation of a single skeleton may require the labor of many weeks. Enough has been already accomplished, however, to exhibit the character of this very remarkable fauna in its main outlines and to permit a general statement of its most salient features. Long and patient study will still be necessary before the full significance of this peculiar assemblage of mammals can be made apparent.

The geological age of the Santa Cruz beds has long been a matter of dispute, because the lack of fossils common to that formation and the standard horizons of the northern hemisphere has prevented any direct comparison. Ameghino, to whose indomitable energy so much of our knowledge of Patagonian fossils is due, has always maintained the lower Eocene age of the Santa Cruz beds. On the other hand, European and American paleontologists have been convinced, from the grade of evolution attained by the Santa Cruz mammals,

* Abstract of a paper read before the Princeton Biological Club, November 16, 1900.

that the horizon could not be so ancient and that it much more probably belonged to the Oligocene or Miocene. Fortunately, the solution of this problem does not depend upon theoretical views of mammalian morphology, but may be decided by more direct and satisfactory evidence. The Santa Cruz beds overlie and are, to some extent, interstratified with the marine Patagonian formation, which is very richly fossiliferous and from which Mr. Hatcher gathered very extensive collections of marine invertebrates. These have been carefully studied by Dr. Ortmann, who concludes from his examination that the Patagonian beds are *Lower Miocene*, and the Santa Cruz beds, as a whole, are, therefore, still younger, that is, Middle, or possibly even Upper Miocene.

The first impression that an examination of a representative series of Santa Cruz fossils makes upon the northern observer is that of strangeness, of unlikeness to everything with which his previous studies have made him familiar, and this impression is only deepened as these mammals are compared with those of North America and Europe. Disregarding some very doubtful and incompletely known groups, the Santa Cruz fauna is composed of the following elements.

1. Marsupialia.
2. Unguiculata,
   (*a*) Insectivora,
   (*b*) Edentata,
   (*c*) Rodentia.
3. Ungulata,
   (*a*) Typotheria,
   (*b*) Toxodontia,
   (*c*) Astrapotheria,
   (*d*) Litopterna.
4. Primates.

One of the most striking features of this fauna may be described negatively, by what it lacks; it has no Carnivora or Creodonta, no Chieroptera (though little importance can be attached to this fact, which may well be accidental); no Artiodactyla, Perissodactyla, Proboscidea or Hyracoidea. Of the nine orders only four are found in the Miocene of the northern hemisphere (for the Old World Edentates, so called, are of no significance in this connection), and even these common orders are represented by totally different suborders and families. That Patagonia had long been cut off from any land communication with North America seems abundantly clear.

The Santa Cruz Marsupials are of two types: (1) Carnivorous animals, which took the place of the carnivores and creodonts of the North; these find their nearest analogues in the *Dasyuiidæ* of Australia, but there are such important differences of structure as to indicate a long geographical separation from that family. (2) Herbivorous animals, of small size, quite remote from any of the Australian forms and typified by the existing South American *Cœnolestes* of Thomas.

The Insectivora are represented, so far as is yet known, by only a single genus, *Necrolestes*, which, as Ameghino has suggested, is very like the 'Cape Golden Moles' of Africa, a most interesting fact, the full significance of which is not yet apparent.

The Edentata are found in surprising variety and numbers, making up one of the most conspicuous and characteristic elements of the fauna. Forerunners of the huge Ground-sloths (Gravigrada) of the Pleistocene, are extremely abundant and are represented in the collection by a number of such well preserved skeletons that a comparison with their great descendants cannot fail to yield results of much interest. One difference is obvious at the first glance, namely, the very much smaller size of the older genera. Much the same statement is true of the Glyptodonts, which are very numerously represented by species much smaller and more primitive than their Pleistocene successors. The Armadillos are likewise extremely varied and abundant, representing not only the various modern subdivisions of the family, but also some

extraordinarily interesting and curious extinct lines. Ameghino has already called attention to some of the peculiarities of these Santa Cruz Armadillos, such as the movable arrangement of the bony scutes of the carapace, which do not form a fixed shoulder-shield, and the imbricatin , overlapping disposal of the scutes in several of the species. As yet no member of the Ant-eaters or true Sloths has been detected in the collection, and it is still too early to say whether this absence is due to the accidents of fossilization and of collecting, to geographical and climatic factors, or to the fact that these families had not yet become distinctly separated from the others.

Even more surprisingly abundant and varied are the Rodentia, of which a remarkable number of genera and species may be distinguished. These are, without one certainly known exception, members of the Hystricomorpha and are all closely allied to types which continue to flourish in South America at the present time. Indeed, several of the fossils cannot be generically separated from living forms. In all this great assemblage of rodents are to be found no beavers, marmots or squirrels, no rats or mice, no hares, rabbits or pikas, but only a bewildering variety of cavies, pacas, chinchillas, agoutis and the like. In no mammalian order are the isolation of the Santa Cruz fauna and its separateness from that of the northern hemisphere more clearly displayed than in the Rodentia.

Still more peculiar are the hoofed-animals. The four orders into which this great series is divided in the table do not represent the results of mature study, but merely of a preliminary survey of the material, and the number of ordinal groups is subject to increase or diminution, as may be the outcome of more careful examination. Of the four orders not one is known in the Miocene of the northern hemisphere, nor, on the other hand, does the Santa Cruz contain representatives of any ungulate order common to it and the northern continents. All the four orders, except the Astrapotheria, continue into the Pleistocene, when most of them had become beasts of great stature or bulk; but then they all disappeared completely and have left no descendants in the modern world.

The Typotheria are individually much the most numerous of the Santa Cruz ungulates and they are, within certain narrow limits, extraordinarily varied. They are all small animals, some of them very small, and except for their long tails, of an aspect which strongly suggests relationship with the Hyracoidea. Whether this resemblance is anything more than an analogy, remains to be determined by a series of careful comparisons. This phylum terminates in the rodent-like *Typotherium* of the Pleistocene, an animal which, though only of moderate size, is yet very much larger than any of its Santa Cruz predecessors. The order has not been found outside of South America.

The next most abundant of the Santa Cruz ungulates is the order Toxodontia, which is very much less varied than the preceding group, though its members are much larger in size. These relatively massive, short-legged and short-footed animals are remarkable for the great size of their heads and for their curved, persistently growing teeth. This line also terminates in the Pleistocene in the great *Toxodon*, which ranged as far north as Nicaragua. The supposed representatives of the order which have been reported from Europe are simply mistakes of identification.

Most remarkable and interesting of all the Santa Cruz ungulates are the Litopterna, which in many respects closely parallel the Perissodactyla. Of these there are two series, one of long-legged, long-necked, camel-like animals, which led up to the

Pleistocene *Macrauchenia;* the other an astonishing imitation of the horses, an imitation so detailed and so close that it has misled Ameghino into believing that this is the actual phylum of equine descent. The resemblance is striking in all parts of the structure; in the teeth, the skull, the backbone, the limbs and especially the feet. The less advanced forms have tridactyl feet, but with the lateral digits already greatly reduced, while the more differentiated species surpass the true horses in strict monodactylism, the splint-bones being almost suppressed and represented only by minute nodules of bone. Yet these wonderfully horse-like creatures prove, on examination, to be not even perissodactyls! A more remarkable and instructive case of convergent evolution it would be difficult to imagine.

The Astrapotheria were the largest of Santa Cruz mammals. In them the great, vaulted skull had such shortened nasal bones as to suggest the presence of a proboscis, and slender, edentulous premaxillaries. The canine teeth in both jaws are enlarged to form powerful and formidable tusks, the premolars are reduced in size and number, while the molars are enlarged. The grinding teeth display a remarkable likeness in size and pattern to those of the northern rhinoceros, *Metamynodon*, from the White River beds—another example of convergent development. The Astrapotheria would appear to have become extinct before the Pleistocene, and it must be the object of subsequent studies to determine whether the group is really entitled to ordinal rank, or whether it should be referred to the Litopterna.

I am not prepared to express an opinion as to the taxonomic position of *Homalodontotherium*, one of the most curious of the many curious Santa Cruz hoofed-animals.

The Primates are not very well known as yet, for the fossils are seldom so complete as those which so often rejoice the heart of the student who works with the other groups. So far as they are understood, the Santa Cruz monkeys would appear to be as characteristically South American, and as different from those of the northern hemisphere, as we have seen to be the case among the Rodentia.

This exceedingly brief outline sketch will have served its purpose if it makes clear the wonderful character of the Santa Cruz fauna and its radical differences from the contemporary life of the northern hemisphere. Much remains to be done before the full account of these splendid collections can be published. I have attempted merely to describe their general nature and the impression which they make upon an observer whose studies have hitherto dealt with northern types.

W. B. Scott.

Princeton University.

IS THERE ANY DISTINCTION BETWEEN SEXUAL REPRODUCTION AND ASEXUAL REPRODUCTION?

The following pages contain rather a full outline of the views advanced by Professor Richard Hertwig in a recent lecture* in which he discusses the relation between fertilization and reproduction. I have endeavored to make this more in the nature of an abridged and revised translation than a review, for it seemed best to follow as closely as possible Professor Hertwig's own way of presenting the subject, which is as follows:

Everyone will admit that most of our general conceptions in biology are greatly influenced by our knowledge of the higher animals and plants. This fact is made very evident to all who study the reproduction

* 'Mit welchen Recht unterscheidet man geschlechtliche und ungeschlechtliche Fortpflanzung?' Vortrag, gehalten am 7, November, 1899. Aus den Sitzungsberichten der Gesellschaft für Morphologie und Physiologie in München. 1899. Heft. II.

of Protozoa, and the inevitable conclusion from such study is that our schema of the kinds of reproduction needs reforming.

In common usage we distinguish the sexual multiplication of animals, in which the formation of the new individual is preceded by an act of fertilization, from the asexual multiplication which takes place without fertilization. The existence of parthenogenesis makes such a distinction difficult to maintain. We can no longer consider this phenomenon as the 'monogonous' method of reproduction, since the typical cases, which are found in the Arthropods, have apparently been derived from sexual reproduction by the loss of fertilization. The same is probably true of what occurs in the Sporocysts and Rediæ of the Trematodes. In order to overcome this difficulty and place parthenogenesis where it naturally belongs, I would propose for sexual reproduction the term *reproduction by means of germ cells.* But I would not stop with this alone, for my study of Protozoa has developed in my mind a strong conviction that our whole view of reproduction needs a radical reformation.

Reproduction by the asexual method alone was formerly considered an important characteristic of the Protozoa, but this breaks down entirely in the face of the increasing number of observed cases in which true fertilization occurs. From the observations recorded for Ciliates, many Flagellates, Rhizopods of the most widely different orders and numerous Sporozoa, I believe that *fertilization occurs in all Protozoa,* and that its rarity and the difficulty of demonstration are the only reasons its general occurrence has not hitherto been observed.

A still further objection to the term *sexual reproduction* arises from the fact that *we often, if not generally, fail to discover any causal relation between fertilization and reproduction.* The actual reproduction of the Protozoa is accomplished either by their division into two or more individuals of equal size or by the pinching off of smaller daughter animals from a larger mother. Now, before we have a right to speak of reproduction as 'sexual,' we must show that fertilization exercises a determinative influence upon its course. This might be proved by showing that fertilization hastened reproduction or by showing that certain kinds of reproduction occurred only in connection with fertilization. Any such determinative influence is now positively excluded in a large majority of cases.

In the ciliated Infusoria, where fertilization in the Protozoa was first recognized as such and has been most carefully described, conjugation is not the forerunner but the after result of active reproduction. Conjugation is even a hindrance to the multiplication of Infusoria, because the necessary reconstruction of the nucleus often occupies many days, that are lost for the purpose of reproduction. The power of division of an Infusorian which has just finished conjugation is, if anything, less than before, and is never increased. In like manner, the power of division in an Infusorian is not decreased as it approaches the time of conjugation, for when two individuals are separated before the actual nuclear exchange has begun, they will divide even more actively than animals after the conjugation has been normally ended. In fine, one comes to the conclusion that the advent of conjugation in Infusorian cultures is not a favorable sign for their further increase.

Beyond any doubt, fertilization causes a pause in the multiplication of many Flagellates and Rhizopods. Volvox when fertilized yields resting spores, which will only develop after a long period, during which they have been frozen or dried.

The same thing is observed after the conjugation of Algæ, with which *Volvox* is quite rightly placed by most investigators.

The cyst of *Actinophrys sol,* which arises

during fertilization, has exactly the same significance. In *Actinosphærium eichorni* the encystment is connected with multiplication, but the multiplication (making of the primary and secondary cysts) precedes fertilization, and the fertilization itself (fusion of the secondary cysts) leads to a resting period of considerable duration (making of the germ spheres).

In the Protozoa then *a lessened power of division follows upon fertilization.* In many Gregarines encystment is certainly accompanied by fertilization, for the division into pseudo-navicellæ, which in turn separate into the sickle-shaped germs, begins within the cyst. In the Gregarines proper, multiplication seems to be restricted entirely to this encysted condition. In some Sporozoa, on the other hand, there are two kinds of division. Coccidiæ and Hæmosporidiæ multiply in the tissues of their hosts by division and without fertilization (auto-infection). At length, however, peculiar divisions begin which are characterized by two things, (1) that they are prepared for by fertilization and (2) that the transportation from one host to another is necessary for their proper course. The fertilization may be completed in the old host, but the multiplication is connected with the transportation into a new one or with some change of place. Since a regular cycle between division with and division without fertilization is here established and each kind of division has its peculiarities, we may speak of an alternation of generations as Schaudinn has done. Another illustration of alternation of generations would be the reproduction of *Noctiluca.* This form multiplies for a long time by ordinary fission. Cross-fertilization then takes place between two individuals, each of which produces a generation of zoospores, which in turn grow up to *Noctilucæ.* According to Schaudinn's description, *Trichosphærium sieboldi* is still another example.

The above *résumé* shows that in all the cases cited multiplication by division, and after a time the advent of fertilization, is constant. There is, however, the greatest diversity in the relation between fertilization and division. There are three possible cases, (1) the fertilization is the cause which stops the division (*Volvox, Actinosphærium, Actinophrys*), (2) the fertilization is the cause which brings about division of another sort which is often very rapid (*Noctiluca*), (3) the fertilization has no marked influence upon the power of division, because the same kind of division prevails after fertilization as before.

In view of these facts is it possible to speak of 'sexual' reproduction in the Protozoa? I think we cannot use such a designation without causing false conceptions of the relation between reproduction and fertilization. There exists in the Protozoa only one kind of reproduction, *i. e.*, division in its manifold varieties. Besides this the Protozoa need to reorganize the structure of their unicellular bodies by fertilization. What the nature of this reorganization is, or its physiological significance, I will not attempt to discuss.

Fertilization is thus interposed from time to time in the life history of a Protozoan. The life epoch at which this interposition occurs is often connected with the times of more subordinate importance. It depends upon suitable conditions which always vary according to the conditions of life in the different classes and orders and perhaps even in the families of the same order. In many Protozoa division takes place within the cyst in a manner somewhat similar to what occurs without the cyst in others. Since we attribute no great significance to these differences in encystment, so it would be a mistake to emphasize the question whether the division of a Protozoan was or was not brought into close connection with fertilization. In the Protozoa fertilization

exercises no influence upon the power of multiplication which in any wise differs from the influence exerted by any other vital process of the cell. Fertilization and reproduction are phenomena which may be found together, but which in their essence have no connection with one another.

Leaving the Protozoa, I will now consider the kinds of reproduction in the Metazoa. We formerly supposed that the asexual reproduction of Metazoa had been inherited from the Protozoa and that their sexual reproduction was a new acquisition. This theory prevailed as long as we thought the Protozoa could only reproduce in an asexual manner. The wide distribution of fission and budding in the lower Metazoa and its entire absence in the Molluscs, Arthropods and Vertebrates, seemed to harmonize with such a view. Although I once held this same opinion, I now consider it incorrect. It seems to me much nearer the truth to make just the opposite statement, viz., that the sexual reproduction of Metazoa is a continuation of the method of reproduction in the Protozoa, while the budding and fission of Metazoa are adjustments having only an outward resemblance to the budding and fission of the Protozoa.

If we consider the multicellular animal as a cell community, its life history may be resolved into a series of innumerable cell divisions which were preceded by an act of fertilization. This is the same kind of developmental cycle as we find in many Protozoa. For example, in the Gregarines the formation of the pseudo-navicellæ and later the sickle-shaped germs follow fertilization. The sickle-shaped germ is comparable with the egg cell, for the Gregarine arising from it suspends multiplication until it has been fertilized. A different character would result in the Metazoa, from the fact that most of the products of division remain united and only certain ones, the sex cells, become self-sustaining. While every cell-division in the Protozoa is a similar act of reproduction, we now distinguish between cell-divisions which bring about the growth of existing individuals and those which permit the creation of new individuals. There is a further difference. The cells which effect the growth and life functions of the multicellular organism, the somatic cells of Weismann, have an enormous power of multiplication. The sex cells which are differentiated sooner or later differ from these proliferating cells in that they lose their power of division relatively early. Their characteristic maturation processes are the last expression of this power. The need of fertilization does not necessarily result from multiplication because the sex cells stop multiplying much sooner than the somatic cells which they closely resemble in all other respects. The cell community needs the combination of different kinds of idioplasm and therefore has seized the opportunity which is presented when the organism is in a unicellular state.

Our conclusion here is similar to that reached in the Protozoa. The occasional mingling of two idioplasms is necessary for the integrity of the cell's life and this is fertilization in the narrower sense. A second phenomenon may be associated with it, viz., the stimulus to development or reproduction. While in the Protozoa fertilization is now connected with reproduction and now separated from it, in the Metazoa it is always combined with reproduction. The two occur together as a necessary consequence of the multicellular condition, for a mingling of two idioplasms is possible only when the whole organism is contained in a single cell. We have thus fallen into the error of considering fertilization and reproduction inseparable. The recent investigations upon the details of fertilization have caused some of us to break away from this idea, but our opinion has not extended sufficiently to produce a general conviction

that reproduction and the combination of idioplasms are separate phenomena.

To emphasize the difference between the two processes suppose we consider fertilization as a complicated morphological process, and reproduction as something which can be accomplished in another way. The first serves to unite substances which possess a stable organization. The second, like all cell-divisions, merely changes a physiological condition of equilibrium. Parthenogenesis is an example of how the power of development may be present in the absence of fertilization. My own view of this phenomenon is that the necessary reciprocal relations of nucleus and protoplasm are in some way established and division ensues. The so-called fertilization of non-nucleated egg-fragments seems to me an analogous case which no one who considers the nuclei the bearers of the idioplasm can call true fertilization. It is much more likely that the necessary reciprocal relation is established by a fusion of the egg-plasm with the plasma of the spermatozoan, in which event we should be dealing with a counterpart of parthenogenesis.

It would therefore be entirely conceivable that the conditions necessary to division could be produced in ripe unfertilized eggs by chemico-physical influences. Loeb's observation that the eggs of sea-urchins (*Arbacia punctulata*) develop to plutei if they have been previously exposed to the action of a certain salt solution, raises no theoretical objections to this view. I have myself succeeded in making unfertilized eggs develop after treatment with chemical reagents (strychnine), although they possessed the power of development to a lesser degree.

It would be of the greatest interest to trace the sexual reproduction of the Metazoa from its origin in the reproduction of unicellular forms. Unfortunately the solution of this problem is made the more difficult by the wide gap which separates the Protozoa and the Metazoa. The Mesozoa are not suitable for our purpose. Their development is not sufficiently known and has probably been modified by the entire class having become adapted to a parasitic life. Nevertheless the investigations upon the best known Dicyemidæ give strong indications that their reproduction still follows the method of the Protozoa. The endoderm of *Dicyema* produces reproductive cells which in many cases yield young animals directly, in others probably after previous fertilization. The first process serves for auto-infection ; the last probably occurs when the parasite would be carried to a new host. The first is known in an entirely arbitrary way as parthenogenesis, when the criterion of parthenogenesis (loss of fertilization) is not proved. It evidently corresponds to the so-called asexual reproduction of the Protozoa. When their multicellular condition and the modifications which it entails are considered the development of the Dicyemidæ seems to admit of a very close comparison with the development of the likewise parasitic Coccidiæ and Hæmosporidiæ.

Plants offer a much more favorable field for the solution of this problem than animals because they exhibit many forms midway between the uni- and multicellular organisms. In the multicellular Algæ there are two kinds of reproduction: (1) asexual, by means of spores and (2) sexual by means of gametes. Both have in common the fact that single cells separate from the cell community and grow up into new plants. In the first case it is each time a single cell for itself, in the second a cell which has previously copulated with one of a different stock. The difference between spores and gametes is often quite pronounced both in their structure and their method of development. In other cases the anatomical and developmental differences

are wiped out. It sometimes happens that cells which are in every other way like gametes develop without fertilization, if they are prevented from copulating. This seems to be analogous to the gradation in the need of fertilization which is found in the Protozoa. We are further reminded of the Protozoa by the fact that fertilization often leads to the formation of resting spores.

If we now attempt an accurate statement of the kinds of reproduction in the plant and animal kingdoms, the old conception of sexual and asexual reproduction must be given up entirely and replaced by the following statement.

All organisms effect their reproduction in a common way by means of single cells which have arisen by cell-division. In single-celled organisms every cell-division is an act of reproduction and results in the formation of another physiologically self-sustaining individual. In multicellular animals, most of the cell divisions lead to the growth of the multicellular individual and only certain of them serve for reproduction. Fertilization goes on side by side with reproduction, because the organism cannot attain its highest development without the union of two individualities by nuclear copulation. Fertilization in its essence has nothing to do with reproduction. In many single-celled organisms the two occur quite independently and are united for what we call sexual reproduction only under special conditions. Such special conditions are imposed upon all multicellular animals, since a mixture of two idioplasms could be easily accomplished only during the unicellular stage. Hence fertilization takes place when the single-celled reproductive bodies are formed. It in no wise follows that all such reproductive bodies must be fertilized. One would naturally expect that reproductive cells not needing fertilization (spores) and such as are destined for fertilization (gametes, eggs, spermatozoa) should exist side by side. This is the case in plants, though in multicellular animals no genuine case of spore-formation has been demonstrated beyond question.

The one case which can be pointed to with strong probability is the above mentioned reproduction of the Dicyemidæ. Everywhere else in the Metazoa spore formation seems entirely supplanted by sexual reproduction. All cases of development from single unfertilized eggs are apparently parthenogenesis and to be explained as sexual reproduction in which fertilization has been lost. The significance of heterogenesis in the di-genetic Trematodes is doubtful. In accordance with the prevailing view, I make a sharp distinction between spore-formation and parthenogenesis resp., heterogenesis, between reproduction by single cells which never have been fertilized and reproduction by cells in which the fertilization has been lost. I doubt if such a distinction could be practically carried out in every case. As long as the reproductive cells are developed in special germinal glands, as for example in the Crustacea, there can be no doubt that we are dealing with parthenogenesis. It is quite different, however, where no egg-glands are differentiated, as in the Rediæ and Sporocysts of the Trematodes. In such cases only a more accurate study of the first stages of development will elucidate the matter. In all cases of parthenogenesis which have been carefully investigated the maturation has been preserved. This has hitherto been always regarded as the forerunner of fertilization. Even in the Protozoa it is connected with the sexual process. Its existence in reproductive cells which develop without fertilization therefore favors the view that fertilization formerly did take place. On the other hand, one would suppose that spore-formation, like the ordinary division of the Protozoa, is without polar bodies. Unfortunately we can only speculate upon

this exceedingly interesting question, for so far as I know the literature, not one case of spore-formation has been carefully investigated and most cases of parthenogenesis insufficiently. And yet such investigations, particularly in the lower plants and animals, would be a profitable and important work.

In my summary I have not mentioned the budding and the fission of the multicellular animals and the so-called ' vegetative reproduction ' of plants. We commonly unite these processes with the budding of the Protozoa and the spore-formation of the Algæ, under the name of asexual reproduction. I have considered them only briefly as new acquisitions of multicellular organisms. In ' vegetative reproduction ' whole multicellular stocks are set free from a mother animal which has rapidly increased in size. The phenomenon presents the greatest diversity. The budding of the Tunicates is quite different from that of the Bryozoa or Hydroids or from the fission of the Annelids. The diversity in the forms of vegetative reproduction is still greater in plants. The investigations in the past twenty years have also proved that the division and budding of the Metazoa do not follow the laws laid down by the germ layer theory. In this respect they resemble regeneration. The whole matter will be a self-evident phenomenon if we accept the view of reproduction which I have set forth above and recognize in the division and budding of the multi-cellular animals adaptive phenomena which have come about in the several groups independent of their development. These processes of asexual reproduction are well named by the botanist ' vegetative reproduction.' If they are more common in the lower than in the higher forms it is because the higher organization sets a limit to the vicarious substitution of one part for another. Similar conditions therefore underlie vegetative reproduction and regeneration and there are many analogies between the two processes. It is worth noticing that in the lower plants, where spore-formation is very common, ' vegetative reproduction,' if we use the term as we have just defined it, is not present. Stocks which have been accidentally broken off from the threads of Algæ can, it is true, develop further, but under natural conditions the Algæ seldom make use of the process for reproduction.

WINTERTON C. CURTIS.
JOHNS HOPKINS UNIVERSITY.

*STUDY OF THE CORRELATION OF THE HUMAN SKULL.**

THE substance of this paper was a thesis for the London D.Sc. degree; it was shown to Professor Pearson, at whose suggestion considerable modifications were made, and a revision undertaken with a view to publication.

In order to deal exactly with the problem of evolution in man it is necessary to obtain in the first place a quantitative appreciation of the size, variation and correlation of the chief characters in man for a number of local races. Several studies of this kind have been already undertaken at University College. These fall into two classes, (i) those that deal with a variety of characters in one local race, and (ii) those which study the comparative value of the constants from a variety of races. Thus Dr. E. Warren has dealt with the long bones of the Naqada race,† Mr. Leslie Bramley-Moore has compared the regression equations for the long bones from a considerable number of races in a memoir not yet published, Professor Pearson has dealt with the regression equations for stature and long bones as applied to a

* 'Data for the Problem of Evolution in Man,' No. VI. By Alice Lee., D.Sc., with some assistance from Karl Pearson, F.R.S. Abstract read before the Royal Society of November 15, 1900.

† *Phil. Trans.*, B, Vol. 189, p. 135.

variety of races;* Miss A. Whitely has studied the correlation of certain joints of the hand,† and is investigating the correlation of the bones of the hand in a second local race; Miss C. D. Fawcett has made a long series of measurements on the Naqada skulls, and correlated their chief characters; the present memoir, on the other hand, deals with only a few characters, in the skull, comparing, however, the results obtained from a variety of local races.

It is thus related to Miss Fawcett's work much as Mr. Bramley-Moore's to Dr. Warren's, *i. e.*, it endeavors, by selecting a few characters and testing them, to ascertain how far results obtained for one local race are valid for a second. In Professor Pearson's memoir on the reconstruction of the stature of prehistoric races, results obtained from one local race were then extended to a great variety of other races. The degree of accuracy in this procedure can only be fully ascertained when the data now being collected in both English and German anatomical institutes are available for calculation.

The skull, however, differs very widely from the stature and long bones; for while these have a very high degree of correlation in all local races, the chief characters of the skull are very loosely correlated, and such correlation as they possess varies in a remarkable manner with sex and race. This was first indicated by Professor Pearson;‡ it has been amply illustrated in the measurements of Miss Fawcett, and is confirmed in a recently published memoir by Dr. Franz Boas. It may be said that this want of correlation in the parts of the skull is the origin of its great importance for the anthropologist; it is the source of its personal and racial individuality. But this anthropological advantage, is, from the standpoint of organic evolution, a great disadvantage. Cuvier introduced the conception of correlation with the idea of reconstructing from a single bone the whole skeleton and even the outward form of an extinct animal, but the great want of correlation between the parts of the skull, and between the skull and other parts of the human skeleton, renders quantitative reconstruction — and this is the really scientific reconstruction —of one character of the skull from a second, or of the skull and parts of the skeleton from each other extremely difficult, if not impossible, for all but a very few characters.

Among these characters one of the most feasible to deal with, and one of the most useful, is the capacity of the skull. This is correlated to a fairly high degree (although to nothing like the same extent as the long bones among themselves) with the maximum length and breadth, with the total and auricular heights, and with the horizontal and vertical circumferences of the skull. The present memoir deals in the main with the problem of the reconstruction of the capacity from these characters.

Three fundamental problems arise in the theory of reconstruction, *i. e.*, the determination of the probable value of an unknown character from a known and measurable one, or from several such. Namely:

I. The reconstruction of the individual from data for his own race.

II. The reconstruction of the average value of a character in one local race from data determined for a second local race.

III. The determination of the probable value in an individual of characters not measurable during life from characters which are measurable.

These three problems are all dealt with for the special character capacity of the skull in the present paper. Their impor-

* *Phil. Trans.*, A, Vol. 192, p. 169.

† *Roy. Soc. Proc.*, Vol. 65, p. 126.

‡ *Phil. Trans.*, A, Vol. 187, p. 279, and *Roy. Soc. Proc.*, Vol. 60, p. 495.

tance may be indicated by the following considerations:

(*a*) Many, especially of the more ancient and accordingly of the more interesting skulls, are too fragile or too fragmentary to allow of their capacity being directly determined.

(*b*) The methods for directly determining capacity are still not only very diverse, but divergent in result, and from the physical standpoint, crude and inexact. In the concordat of the German craniologists—the *Frankfürter Verständigung*—the point was left for future consideration, and so it has remained for many years. The capacities of series of skulls determined during the past forty years in France, England and Germany are, we are convinced, not comparable, at least if the argument from the comparison is to depend on a difference of 30 to 40 cm.[3] While the same observer using different methods may be trained to get results within 4 to 6 cm.[3] for the same skull, different observers, equally careful, using the same method, will easily get results for the same series diverging by 20 to 30 and even more cubic centimeters. Shortly, the personal equation—involved in the packing in the skull and in the measuring vessel—is very large.

Accordingly a regression equation for the capacity as based on external measurements may, if deduced from a sufficiently large range of series measured by careful independent observers, give results fairly free from the error of personal equation and this sensibly as correct as, or more correct than, direct measurement when we require the mean capacity of a series.

(*c*) It is impossible to obtain a large series of skulls belonging to known individuals with a classified measure of intellectual ability. Actually we have only a few skulls of men of great intellectual power, sometimes preserved because they were large, and to compare with these the skulls of the unknown and often the ill-nourished, which reach the anatomical institutes.* Accordingly it is an investigation of considerable interest to compare the *probable* capacity of the skulls of living persons with their roughly appreciable intellectual grade. It is only by such a comparison that we can hope to discover whether the size and shape of the skull is to any extent correlated with brain power.

In the course of the memoir it is shown that the auricular height of the skull is a better measurement for determining skull capacity than the total height; that the circumferences of the skull, while highly correlated with its capacity, give regression equations which vary widely from one to another closely-allied race; that linear regression equations involving length, breadth and auricular height, while giving fairly good results for individuals within the local race, have very divergent coefficients as we pass from local race to local race; that the cephalic index has very little correlation with capacity at all; as a rule what there is may be summed up in the words: In a brachycephalic race the rounder the skull the greater the capacity, in a dolichocephalic race the narrower the skull the greater the capacity—the greater capacity following the emphasis of the racial character; finally, that the correlation of capacity with the triple product of length, breadth and height gives a regression equation which is fairly constant from local race to local race, and is accordingly the best available.

From this and other equations individual and racial reconstructions are made, and the deviations between the actual and predicted capacities in randomly chosen series of skulls are tabulated. The mean error made in the reconstruction of the individual capacity by the best formulæ is 3 to 4

* This argument applies also, in even an intensified degree, to the determinations of brain weight.

per cent., the maximum error, although of course infrequent, may even be ten per cent. For the reconstruction of the mean capacity of a race, the mean error is about 1.2 per cent., with a maximum error of 2.5 per cent. If these errors appear large to the craniologist, we would remind him that his search for an absolutely correct formula giving cranial capacity from external measurements is the pursuit of a will o' the wisp. The theory of probability shows us exactly the sort of errors such formulæ are liable to, and teaches us how to select the best. The whole basis of the theory of evolution, the variability of one character, even with fixed values for a number of others, would be upset if any such absolute formula were forthcoming. What we have to do is to select a few organs as highly correlated as possible, but, having done this, it has been shown elsewhere that we shall not sensibly decrease the error of our prediction by increasing the number of organs upon which the estimate is based.* Accordingly we do not believe that sensibly better reconstruction formulæ than those found will ever be forthcoming, for, as we have already observed, we know from Miss Fawcett's wide series of skull correlations that we have practically chosen the organs of the highest correlation. Better data for determining the equations will undoubtedly be available as further craniological measurements are made, or as the great mass already made are quantitatively reduced.

In the last place we turn to the third problem: the reconstruction of the capacity of the living head. The memoir contains tables of the skull capacity of some sixty men, and also of some thirty women, whose relative intellectual ability can be more or less roughly appreciated. It would be impossible to assert any marked degree of correlation between the skull capacities of these individuals and the current appreciation of their intellectual capacities. One of the most distinguished of continental anthropologists has less skull capacity than 50 per cent. of the women students of Bedford College; one of our leading English anatomists than 25 per cent. of the same students. There will, of course, be errors in our *probable* determinations, but different methods of appreciation lead to sensibly like results, and although we are dealing with skull *capacity*, and not brain weight, there is, we hold in our data, material enough to cause those to pause who associate relative brain weight either in the individual or the sex with relative intellectual power. The correlation, if it exists, can hardly be large, and the true source of intellectual ability will, we are convinced, have to be sought elsewhere, in the complexity of the convolutions, in the variety and efficiency of the commissures, rather than in mere size or weight.

* *Phil. Trans.*, A, Vol. 190, p. 466.

AMERICAN ORNITHOLOGISTS' UNION.

THE Eighteenth Congress of the American Ornithologists' Union convened in Cambridge, Mass., Monday evening, November 12th. The business meeting was held in Mr. William Brewster's Museum, and the public sessions, commencing Tuesday, November 13th, and lasting three days, were held in the Nash lecture room of the University Museum.

Dr. C. Hart Merriam, of Washington, D C., was elected President; Charles B. Cory, of Boston, and C. F. Batchelder, of Cambridge, Mass., Vice-Presidents; John H. Sage, of Portland, Conn., Secretary, and William Dutcher, of New York City, Treasurer. Frank M. Chapman, Ruthven Deane, E. W. Nelson, Witmer Stone, Drs. A. K. Fisher, Jonathan Dwight, Jr. and Thos. S. Roberts were elected members of the Council. By a provision of the by-laws, the Ex-Presidents of the Union, Dr. J. A. Allen and Messrs. William Brewster, D. G. Elliot

and Robert Ridgway are *ex-officio* members of the Council.

One honorary, two corresponding and seventy associate members were elected.

A change in the by-laws was proposed whereby the present class of active members shall be known as fellows; the present class of associate members to be known as associates, and to establish a class of membership intermediate between fellows and associates, to be known as members. The matter will be brought up for final action at the next Congress of the Union.

Miss Juliette A. Owen, of St. Joseph, Mo., an associate member, who so kindly remembered the Union at the last Congress, sent an additional $100 this year. This will be added to a fund, the income of which is to be used for the advancement of the science of ornithology.

An address in commemoration of Dr. Elliott Coues, a distinguished member, and a former president of the Union, who died since the last Congress, was delivered by Professor D. G. Elliot. Dr. Coues became eminent in science, and did more perhaps than any other person to stimulate in young people an interest in birds. Dr. J. A. Allen presented a memorial address on the Hon. Geo. B. Sennett, an active member of the Union, who died during the past year. Mr. Sennett, although deeply engrossed in business, never lost his taste for ornithology. His writings relate mainly to the birds of Texas.

The report of the Committee on Protection of North American Birds, read by its Chairman, Mr. Witmer Stone, showed that satisfactory results had been obtained during the past year. One important feature was the protection of the gulls and terns along the coast, made possible by money secured through the efforts of Mr. Abbott H. Thayer. Mr. William Dutcher, who had special charge of this phase of the work, made a supplementary report, giving in detail the localities where the birds were found and eventually saved. These reports will be published in *The Auk*, and reprinted as a separate pamphlet, to be sold at a very low price for general distribution.

Judge John N. Clark's 'Dooryard Ornithology' was a popular and well presented paper. Mr. Clark lives in Saybrook, Conn., and in the restricted area about his house he has noted the occurrence of more than one hundred species of birds.

From letters written to the late Spencer F. Baird, Mr. Witmer Stone was able to obtain, by courtesy of Miss Lucy H. Baird, interesting facts about many of the older ornithologists. These he embodied in an important historical paper called 'The 'American Ornithologists' Union' of 1840–45.' It is difficult to realize at the present time the discomforts and disadvantages that confronted workers in any science sixty years ago.

Two afternoons were devoted to papers illustrated by lantern slides—all showing what an aid photography now is to the study of the habits of birds.

Following is a list of the papers read at the sessions in addition to those already mentioned:

'The Sequence of Moults and Plumages of the *Laridæ* (Gulls and Terns)': JONATHAN DWIGHT, JR.

'A Study of the Genus *Sturnella*': FRANK M. CHAPMAN.

'The Pterylosis of Podargus; with Further Notes on the Pterylography of the *Caprimulgidæ*': HUBERT LYMAN CLARK.

'The Moult of the North American Shore Birds (*Limicolæ*)': JONATHAN DWIGHT, JR.

'Nesting of the Yellow-headed Blackbird.' Illustrated by lantern slides: THOMAS S. ROBERTS.

'Among the Terns at Muskeget, and on the New Jersey Coast.' Illustrated by lantern slides: WM. L. BAILY.

'The Season of 1900 at the Magdalen Islands; with remarks on bird photography.' Illustrated by lantern slides: HERBERT K. JOB.

'Field Notes on a few New England Birds.' Illustrated by lantern slides: WILLIAM BREWSTER.

'Notes on the Spring Migration (1900) at Scarborough, N. Y.': LOUIS AGASSIZ FUERTES.

'Impressions of Some Hawaiian Birds': H. W. HENSHAW.

'A Visit to the Birthplace of Audubon': O. WIDMANN.

'Natural History of the Alaska Coast.' Illustrated by lantern slides: C. HART MERRIAM.

'Notes on a Nest of Massachusetts Brown Creepers.' Illustrated by lantern slides: A. P. CHADBOURNE.

'Bird Studies with a Camera.' Illustrated by lantern slides: FRANK M. CHAPMAN.

'Aptoschromatism.' A reply to Drs. Dwight and Allen: FRANCIS J. BIRTWELL.

'On the Breeding Habits of Leconte's Sparrow': P. B. PEABODY.

'On the Value of Careful Observations of Birds' Habits': EDWARD H. FORBUSH.

'Breeding of the Cerulean Warbler near Baltimore': FRANK C. KIRKWOOD.

'The Enforcement of the Lacey Act': T. S. PALMER.

The next annual meeting will be held at the American Museum of Natural History, New York City, commencing November 11, 1901.

JOHN H. SAGE,
Secretary.

THE WELSBACH LIGHT.*

THE Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts, acting through its Committee on Science and the Arts, investigating the merits of the Welsbach Light, which was referred to the Committee by the Jury of Awards of the late National Export Exposition, 1899, reports as follows:

The procuring of artificial light by some means other than using the flame of burning carbonaceous material in the ordinary candle, lamp or gas burner has been the aim of many investigators. As a result of this endeavor, we find on the one hand lamps in which carbon is heated to a point where it gives off light—or becomes incandescent—as by the passage of an electric current through an incandescent filament or arc lamp crater; or, on the other hand, lamps in which the incandescence of certain substances (oxides of certain of the elements for the most part) is produced by the application of a heating flame or the passage of an electric current to raise their temperature. Of these latter burners, the development of those using a heating flame applied to produce incandescence of rare earths is the particular thing dealt with in this report, but it seems impossible to avoid a mention of others when giving an outline of the chain of discoveries and inventions leading up to the Welsbach light of to-day.

It is probable that Drummond is one of the earliest discoverers of the fact that heated oxides of certain elements incandesce. Certainly he made the first practical application of the fact. Every one knows of the Drummond or lime-light which has been so commonly used in the projection lantern. A piece of lime, or better, a piece of oxide of magnesium, or, most refractory of all, a piece of oxide of zirconium, has an oxyhydrogen flame play upon it and is thereby heated to a temperature at which it incandesces and gives off an intensely-bright white light. Lieutenant Thomas Drummond, in the English government service, made this discovery in 1826, and used it in connection with his heliostat in surveying work, and afterwards proposed the same arrangement for lighthouse service.

In 1868, Le Roux, Professor at the École Polytechnique, Paris, discovered that a brilliant incandescent light might be procured from a rod of lime or magnesia, by heating it until an electric current passes, this afterward maintaining the light.

In 1879, Jablochkoff patented the use of a piece of kaolin as a source of light, making it incandesce by passing an electric cur-

* Being the report of the Franklin Institute, through its Committee on Science and the Arts, on the exhibit of the Welsbach Light Company, of Gloucester City, N. J., referred by the Bureau of Awards of the National Export Exposition. Sub-Committee.—Arthur J. Rowland, Chairman; C. A. Hexamer, Wm. McDevitt, Frank P. Brown, Moses G. Wilder.

rent through it. He had noticed that the kaolin he had placed between the carbons of his arc lamp assisted the illumination.

These inventions show something of the development of knowledge regarding materials which might be made incandescent, and the means taken to make them incandesce.

Several years later, in 1881, W. M. Jackson (an American) invented the device of a lamp made of platinum, iridium or other materials non-oxidizable at high temperatures, in the form of wires of small section which were heated to incandescence by the use of a heating flame. He discovered that the finer his wires, the more intense the light produced. Here is a beginning of a mantle light.

In 1881, Charles M. Lungren, of New York, patented in the U. S. Patent Office an improvement in illuminating apparatus, which consisted in passing a non-luminous gas flame through a heater of clay or similar material highly heated by jets of the non-luminous gas, and forcing atmospheric air through the heater and causing it to mingle with the non-luminous gas issuing in one or more jet flames against lime, magnesia, zirconia or similar material, producing incandescence.

In the same year (1881) Mr. Lungren filed an application in the Patent Office for a means of illumination which consisted in forming a filamentary body of refractory material, said body having the structural form necessary to envelope a gas flame and to be rendered incandescent by such flame.

This application, after allowance by the Patent Office, was permitted to lapse, and no patent was then issued.

Mr. Lungren, however, renewed his application in August, 1885, and the patent, which embodied improvements upon his unissued patent of 1881, was issued July 5, 1887 (No. 365,832). Subsequently, a second patent (No. 367,534), describing specific features of his incandescent lighting method, was issued to Lungren under date of August 2, 1887.

In the first of these patents Lungren describes his method of making refractory filaments for lighting composed of 'lime, magnesia, zirconia, etc.,' by preparing a plastic mass of these materials, or mixtures of them by kneading them with water, or preferably, a solution of a mucilaginous binding material, such as glue or gum, or other combustible material which will be consumed in the further treatment of the filament. When the mass is of the proper consistence, it is put in a press and the filament is obtained by expressing the material through a die. Immediately after their formation, and while still moist, the filaments are formed up into various shapes desired by bending or coiling over a mandrel of wood coated with plumbago, or other device, and then dried, when they are ready to apply to a support and to be used in connection with a gas flame, in substantially the same manner as the well-known Welsbach mantle.

The Lungren incandescent lighting system was the subject of investigation by the Committee on Science and the Arts of the Franklin Institute in 1891. Prolonged practical tests of the Lungren filaments showed that they possessed unusual life duration in service, with satisfactory lighting quality; and the award of the John Scott Legacy Premium and Medal was made to the inventor.

For reasons unknown to your committee, this promising invention was never commercially exploited.

The next year (1882) a Frenchman, Charles Clamond, invented a lime light operated without oxyhydrogen flame by intensely heating the air used and directing the flame of his air and gas mixture against the refractory oxide chosen. He knew of the possible use of certain other metallic

oxides to produce an incandescent light, and even invented a basket or mantle of magnesia threads, supported in an enclosing platinum mantle of small wire and large mesh, which was hung below the lamp and the heating flame directed down into it. The threads were made from magnesia which was calcined and pulverized, then made plastic by mixing with salts of magnesia, which may be afterwards decomposed by heat, then squirted through a die, woven into a basket form and dried and baked.

In 1885, Otto B. Fahnehjelm, a Swedish inventor, secured an American patent (see U. S. Patent No. 312,452, February 17, 1885) for an incandescent light which consisted in the combination with a suitable gas burner and a shade holder of means for suspending an incandescent body in the flame of the burner, and for adjusting the incandescing body horizontally and vertically in relation to the flame. The Fahnehjelm light consisted substantially of a series of rods of calcined magnesia, resembling the teeth of a comb, held in a suitable frame and suspended in a non-luminous flame of gas.

In 1886, Galopin and Evans (in Australia) produced a lamp burning hydrocarbon vapor mixed with air to produce a heating flame, directed downwards into a woven platinum mantle, which was thus made incandescent.

About this same time, or even a little earlier (1885), Carl Auer von Welsbach announced the invention of a lamp in which the rare oxides of lanthanum, yttrium, zirconium, etc., in a finely divided condition, were rendered incandescent by heating to a high temperature. The source of light was a light network of cotton thread impregnated with a solution of the salts of the combined nitrates, oxides or bromides. After being saturated with these, upon exposure to heat, the supporting cotton network was burned out, the salts converted into the oxides and a skeleton hood or cap thus prepared, which would incandesce when a heating flame was applied to it.

The absolute originality of this form of mantle and method of manufacture should be carefully noted.

The nitrates of the metals, being very soluble, were especially adapted to the process, although sulphates, iodides or bromides could also be used.

Welsbach found that this mantle, as it came to be called almost from the first, could resist the action of all atmospheric air fit to breathe for an indefinite length of time, was not changed by exposure and would remain effective for a long time.

For the next five years or more von Welsbach was constantly at work making elaborate investigation of the properties of all oxides of metals which would incandesce when used separately, and when combined in various mixtures. He invented processes whereby the salts of the metals required for impregnating mantles might be prepared from the natural ores, originated means for strengthening the frail mantle, arranged the mantles for transportation in safety, and perfected many details making the lamp practical.

It is interesting to notice that the form of mantle and the general process of manufacture have remained up to the present precisely as von Welsbach originally planned them, without improvements or essential modification of any kind.

One or two of the discoveries of von Welsbach are necessarily mentioned a little in detail, to explain the magnitude of the investigations he conducted and the sort of results he procured.

A patent No. 409,531, August 20, 1889, explains that the illuminating power is greatly increased by adding thorium oxide; that lanthanum oxide without sufficient thorium oxide crumbles when incandes-

cent—with it the mantle becomes flexible. Later he found (patent No. 563,524) that thorium oxide, by the addition of a small per cent. of uranium or cerium oxide, has a very high illuminating power, producing a vivid and nearly white incandescent light, in spite of the fact that thorium oxide alone radiates little light which is yellow in color, and that uranium oxide alone radiates little light, and it is yellow reddish. Still later, he discovered that the illuminating power of lanthanum, cerium, yttrium, zirconium and other metals of the refractory earths is greatly increased by the addition of thorium oxide (ThO_2); that cerium not only gives a yellow light (very desirable color), but greatly increases the life of the mantle, causes it to hold its shape better, and makes it in every way stronger and more durable.

Thus we get a slight idea of the elaborate researches conducted by Dr. von Welsbach, and of the many difficulties which had to be overcome before the Welsbach mantle could become practical and commercial.

To complete the story of lights procured by the incandescence of metallic oxides, mention should be made of the lamp invented by Professor Walther Nernst, of the University of Göttingen, early in 1899, the substance rendered incandescent being a magnesia rod through which an electric current is passed after preliminary heating. Not only is this light related to the same group as the Welsbach, not only does it give a very modern illustration of a sort of lamp mentioned earlier in the report, but (most interesting of all) in his latest work Nernst gives up the magnesia and uses the same mixtures of oxides as used in the Welsbach mantle — zirconium, thorium, cerium, erbium, etc.

A very brief description of the lamp and mantle made for use with illuminating gas by the Welsbach Light Company, of Gloucester, N. J., will give the best idea of present methods, and serve to bring out some important points with reference to the light-giving power, durability and economy of the mantle as put on the American market. The Welsbach 'J' mantles (standard until very recently) were made about as follows: A six-cord cotton thread was woven on a knitting machine forming a tube of knitted fabric of rather open mesh. This web has the grease and dirt thoroughly washed out of it, is dried, then cut into lengths double that required for a single mantle. It is then saturated in the fluid (described later), wrung out, stretched over spools and dried. Next, the double length pieces are cut into two, the tops of each piece doubled back and sewed with a platinum wire which draws the top in and provides a means of supporting the mantle when finished from the wire holder. After stretching the mantle over a form, smoothing it down and fastening the platinum wire to the wire mantle holder, the mantle is burned out by touching a Bunsen burner to the top. The cotton burns off slowly, leaving a skeleton mantle of metallic oxides, which are unconsumed, and which preserve the exact shape and detail of every cotton fiber. The soft oxides are then hardened by a Bunsen flame. During burning out and hardening, considerable shrinking takes place. This finishes the process, except the immersion of the mantle in crystalline, to prepare it for transportation, after which it is trimmed and packed. The fluid in which the cotton webbing is immersed is procured from monazite sand, which yields in the finished mantle oxides of thorium and cerium.

The candle-power of mantles of the sort mentioned is about 75 initial candle-power under gas pressure of Philadelphia illuminating gas. This means 20 candles per cubic foot per hour (an ordinary 8-foot fish tail burner gives not over three candle-power

per cubic foot per hour). The life of the mantles is probably not much below 1,000 hours. The candle-power drops quite rapidly at first and more gradually afterwards, going as low as to one-half the initial candle-power before the mantle breaks.

It is hard to tell how much the perfection of detail in burner construction, a proper selection of chimney, and artistic features of design have contributed to procure the very large commercial use of the lamps. Without proper burners the mantle would be of small value. The details of the common burner, the peculiarities of which make it different from the ordinary Bunsen burner in adjustment of gas and air; the gauge distributing device to spread the flame over the whole mantle and so fill the mantle are too well known to merit detailed description.

The mantle first made in America, in 1888, gave only 35–40 candle-power initial, under 10/10 pressure, using 3 to 3.2 feet of gas on 3-inch mantles, and under ordinary conditions not over 8 candle-power per cubic foot of gas used.

The new mantle, known as Balm Hill or, popularly, 'Yusea' mantle, has a much more open mesh than the 'J' mantle, and is made on lace-making machinery. It is thus supposed to be much stronger than the older mantle, and gives about 100 initial candle-power at the mantle when the gas and air are properly adjusted in the burner. Your committee has been unable to gather data of life or decline in candle-power in time to include them in this report.

Certain defects in the mantle light should not be entirely passed over. The mantle is exceedingly fragile and cannot be made to stand where it is subject to continued vibration; the quality of the light is such as to require the adjectives cold, ghastly, harsh, in describing it; and often a greenish tinge in the light is evident. The candle-power drops badly early in the life of a mantle, and is especially subject to this trouble where there is much dust in the air; the oxides seem to volatilize slowly from the mantles, as evidenced by the shrinking in size of strands of mantle and the white deposit on chimney, for platinum melts easily in the part of the flame where the mantles hang.

If the mantle breaks, a hole being thus produced in it, the hot flame strikes out through this, often breaking the chimney, and as a secondary result destroying the mantle itself.

On the other hand, the advantages in the use of the mantle for lighting are shown not only by statements already made, but also by the fact that artificial lighting has been profoundly affected by the commercially-successful mantle. We have systems of lighting using mantles now in which the source of the heating flame is gas, gasoline, kerosene. There are systems using Welsbach mantles in which pressure of large amount, and others in which low pressure is used. There are two great companies, the Welsbach Commercial Company and the Welsbach Street Lighting Company, that do an enormous business and deal only with the use of the Welsbach mantle in lamps using ordinary illuminating gas.

The patents held in this country by the Welsbach Light Company are very broad and fundamental, and have to do with all sorts of details of the system as well. The numbers of the patents of most importance are given below.* Over fifty in all were

*359,524,	March	15,	1887.	Carl Auer von Welsbach.
377,698,	Feb.	7,	1888.	" " " "
377,699,	"	7,	"	" " " "
377,700,	"	7,	"	" " " "
377,701,	"	7,	"	" " " "
390,057,	Sept.	25,	"	Harold J. Bell.
396,347,	Jan.	15,	1889.	Carl Auer von Welsbach.
399,174,	March	5,	"	" " " "
403,803,	May	21,	"	" " " "
403,804,	"	21,	"	" " " "

submitted to your committee. Some of these are not to Welsbach, and yet are for processes of importance in the manufacture of the present American-made mantle and lamp.

In consideration of the enormous advance in the art of artificial lighting made possible by the invention of the Welsbach mantle, the Franklin Institute awards the Elliott Cresson Medal to Dr. Carl Auer von Welsbach, of Vienna, Austria, for his discoveries regarding the metallic oxides which may become incandescent when heated, and for the invention of a mantle by the use of which these metallic oxides are commercially available as sources of artificial light.

Also, in view of the many details wrought out by the Welsbach Light Company, of Gloucester, N. J., in putting a thoroughly practical mantle on the market, the Franklin Institute awards to them, the said company, in addition, the Edward Longstreth Medal of Merit.

UNIVERSITY REGISTRATION STATISTICS.

NOTWITHSTANDING the obscurities, frequent inaccuracies, and baldness of statement inherent in a table of comparative statistics, it is nevertheless believed that our readers will find some degree of interest in the accompanying summary of the statistics of registration at sixteen of the leading

	California.	Chicago.	Columbia.§	Cornell.**	Harvard.††	Indiana.	Johns Hopkins.
College (Arts) Men			464 (18)		1992 (90)	563 (15)	178 (3)
College (Arts) Women	2050(295)	975 (105)	292 (69)	746 (82)	448 (57)	268 (5)	
Scientific Schools*			540 (78)	880 (83)	507 (12)		
Law	121 (15)		427 (50)	176(—1)	647 (34)	110 (10)	
Medicine	171 (10)		751 (—6)	336 (8)	749 (36)		211 (0)
Agriculture				174 (11)			
Art	208 (37)						
Dentistry	152 (3)						
Divinity		180 (—3)			28 (1)		
Forestry				22 (3)			
Music							
Pharmacy	84 (2)						
Teachers College		499 (280)	344 (?)				
Veterinary	2 (0)			41 (12)			
Graduate Schools	20(—8)	330(—56)‡	383 (3)‖	192 (22)	393(15?)‡‡	40 (5)	159(—28)
Auditors			20 (—2)				
Courses for Teachers	†		721(—29)				
Summer Session	433(273)	1790 (154)	417 (417)	464 (40)	987(131)	333 (82)	
Other Special Courses							81 (26)
Deduct double registration			98°		64‡‡		
Grand Total	3221(635)	3774 (480)	4261 (555)°°	2458(218)	5720(382)	1280(137)	629 (1)
Officers	300	225	471 (28)		495 (47)	60	129

407,963, July 30,	"	F. L. Rawson and W. Stepney Rawson.
409,528, Aug. 20,	"	Carl Auer von Welsbach.
409,529, " 20,	"	" " " "
409,530, " 20,	"	" " " "
409,531, " 20,	"	" " " "
438,125, Oct. 7, 1890.		" " " "
463,470, Nov. 17, 1892.		" " " "
563,524, July 7, 1896.		" " " "
26,075 (design), Sept. 22, 1896.		Geo. S. Barrows.

* Includes schools of engineering, chemistry, architecture and mines.

† Included in statistics of college and scientific schools.

‡ Includes 118 students in the 'Ogden Graduate School of Science.'

§ Statistics of November 7th.

‖ Not including 107 professional students who are also candidates for the degree of A.M. or Ph.D.

° Includes 74 Summer Session students who have returned for the fall term.

** Statistics of November 15th.

†† Statistics of November 19th.

‡‡ Includes 52 graduate students in Radcliffe, which number is deducted for double registration.

universities in the United States. Unless otherwise indicated, these statistics represent the registration at the respective universities on November 1, 1900.

Variations in the standard of admission and of required work, in the interpretation of technical designations given to different departments and school of divers institutions, in the practical classification of students, and in matters of educational administration are so divergent that any attempt to squeeze the statistics of sixteen institutions into a rigid form that may meet with the requirements of one or of several of the institutions considered, is manifestly absurd, or at least unwise. It would obviate in mind these facts, we offer the figures which have been received in the approximate form in which they were sent. Uniformity in this matter must, therefore, be relative, not absolute. After all, in the absence of universally accepted stated definitions and requirements which for comparative statistical purposes it would be a happy circumstance to have all universities respect and obey, figures of this character function merely as probable hints, not as basic facts.

We would call attention to a few matters in connection with the table. In every instance an endeavor has been made to ascertain the increase or decrease in the various departments as compared with the

Stanford.	Michigan.	Minnesota.	Missouri.§§	North-western.	Pennsylvania.	Princeton.	Wisconsin.‖	Yale.
	638(—3)	485 (64)	482 (30)	349 (70)	421 (21)	745 (59)	529	1192
1178 (70)	591(—6)	592 (72)		261(—13)			406	
	353 (84)	347 (61)	246 (13)		336 (30)	428 (61)	390	610
185 (24)	809 (88)	480(—48)	115 (9)	175 (5)	344 (32)		258	210
	591 (73)	512(—44)	82 (21)	404 (0)	566(—116)			133
			88(—204)				18	
		590 (87)						75
	278 (34)			560 (30)	415 (—69)			
								89
								7
							125	126
	69(—3)			164 (27)			42	
			59 (—12)					
					57 (11)			
84 (?)	80 (4)	177 (0)	35 (15)	35 (5)	150 (—2)	78(—63)	101	299
			15 (8)		20 (?)			
					230 (—32)			
56(—8)	404(141)	275(—27)	439 (171)				329	
					10 (—9)		60	
							73	205
1318 (62)	3813(219)	3423 (187)	1335 (129)	1948 (124)	2549(—124)	1251 (57)	1856(144)	2536(19)
	220 (13)	8	74 (6)	299	265		156 (20)	

some of the misinterpretations which a comparison of the statistics of the accompanying table may entail, if space permitted a succinct statement of the institutional variations above alluded to. However, bearing

§§ Statistics of November 12th. Registration not completed, particularly in agriculture, the courses of which open late in the term.

‖‖ Statistics of November 15th.

°° Exceptional increase due to first session of Summer Schools in 1900.

registration of 1899. Such increase or decrease where obtainable is represented by the figures in parentheses. Unfortunately, returns are not at hand from several other representative institutions in which there is a common interest. However, the scope of country represented by the institutions herein enumerated is undoubtedly sufficient in extent to indicate the general status and progress of higher education in the United States.

GEO. B. GERMANN.

SCIENTIFIC BOOKS.

One Thousand American Fungi; How to select and cook the Edible; How to distinguish and avoid the Poisonous; giving full botanic descriptions made easy for reader and student. By CHARLES MCILVAINE, assisted by ROBERT K. MACADAM, Indianapolis. Bowen-Merrill Co., with 65 plates, 34 colored, and numerous cuts. Large 8vo. Pp. 704.

The fashion of gathering and eating fungi, which has suddenly become almost a mania with many people in this country, has called forth a considerable number of books and tracts intended to aid those who have no previous knowledge of fungi to distinguish between the edible and poisonous species. As is seen from the title, the present work has for its object to make the subject easy for the reader and the student. The first thing which the student demands is good illustrations, which, in the case of most fungi classed as edible or poisonous, must be colored in order to be recognized at once. Unfortunately the colored plates of Dr. McIlvaine's book are not satisfactory. Too many species are often crowded together on a single plate, the drawing is too sketchy and the colors, which have a washed-out look are not true to nature. The plate of *Clitocybe illudens* is almost the only one of the colored plates which is at all satisfactory and, were it not for the names attached, in many cases expert mycologists would be at a loss to know what species are represented. On the other hand, the photographic reproductions are excellent and, where color is not an essential feature, serve their purpose admirably. Plate 158, a good picture of *Phallus Ravenelii*, is marked *Phallus impudicus*, although the veil characteristic of that species is wanting.

Turning to the text, we are told that the book is the result of ten years' labor and that the author has added over six hundred species to the one hundred and eleven edible species enumerated by the Rev. M. A. Curtis. From this long practical experience of Dr. McIlvaine he must have acquired a large fund of information valuable to the would-be mycophagist. It is to be regretted that the author's style is marked by an absence of simplicity and clearness, and that he is given to repetition and to frequent side remarks in which sentimentality rather than scientific accuracy predominates. A serious fault, due rather to the lack of clearness in writing than to any desire to misrepresent, is the mixing up of what the author has himself observed with what he has learned from the writings of other mycologists and, in too many cases, one who is not already familiar with the literature cannot tell where the quotations from other writers begin and end. One would like to know exactly what has been the result of Dr. McIlvaine's own experience, and that is not always easy to find out. What is said about *Boletinus porosus* illustrates this point. That species is a common and striking fungus in the eastern part of the country and when raw it has a most disagreeable taste which promises little to the mycophagist. One would like to know what has been Dr. McIlvaine's experience with this species. On turning to p. 403 we find only the following statement: "Fine specimens were sent to me by Mr. H. I. Miller of Terre Haute and Dr. J. R. Weist, Richmond, Ind. They were in condition to be eaten and enjoyed. No disagreeable odor was perceptible." Does this mean that Dr. McIlvaine ate the specimens and enjoyed them? His statement is certainly not explicit enough to satisfy those who have been nearly nauseated eating this fungus raw. Whether a fungus is edible or not often depends on circumstances and in any work intended to instruct students the conditions should be stated. To take *Gyromitra esculenta* as an example, Plate VI. is a somewhat sensational representation of a group of dangerous fungi. A small but very red devil is sitting under the shadow of a large skull reading a book called toxicology. In the foreground is a very bad picture of *Gyromitra esculenta* which, from its surroundings, the reader would infer to be deadly. But on p. 547, in speaking of this species, we find the following: 'Since 1882 myself and friends have repeatedly eaten it. In no instance was the slightest discomfort felt from it. It was always enjoyed.' Now the facts in the case of the *Gyromitra* are these: as long ago as 1882 Bostroem* showed that an active poison exists in this species, but it is soluble in boiling water and there-

* Ueber die Intoxication durch die essbare Lorchel. Eugen Bostroem, Leipzig. 1882.

fore, if the water in which the fungi have been boiled is carefully removed, they can be eaten with impunity. If by experiment Dr. McIlvaine has found Bostroem's observations to be incorrect, he should have made some statements to that effect. Otherwise he should have mentioned Bostroem's experiments in the paragraph in which he speaks of the fungus as edible. As it is, we are not even informed whether in his own cases the water in which the *Gyromitra* was cooked was removed or not. That part of the book treating of the poisonous Amanitæ, a subject of vital importance, is by no means clearly written. The facts are given, but they are so ill arranged that they must be obscure to the persons to whom the book is especially addressed.

With regard to that part of the work treating of the species not preeminently edible or poisonous, and they form the greater part of the whole, it may be said that as a summary of species compiled from many scattered sources, it serves a useful purpose, since in the present state of our knowledge anything like a complete or very accurate account of our larger fungi is out of the question. It would have been well to cite the publications where the different species were originally described, as well as the name of the original describer. In the effort to make the list of species described as complete as possible the mistake has been made of accepting without sufficient discrimination the names and descriptions of different authorities, the result being that the same species in several instances appears not only under different names but with different descriptions in a way puzzling to students who attempt to ascertain the specific distinctions.

The chapter by Professor W. L. Carter on 'Toadstool Poisoning and its Treatment' stands out in bright relief from the rest of the book in its clearness and scientific treatment of the subject. There is also a good practical chapter on cooking and preparing fungi for the table and a good glossary, and the press work is all that need be asked. The great merit of the book lies in the record of the large number of species eaten by the author without injury, in the excellent photographic reproductions, the useful although somewhat indiscriminate summary of our native species, and the chapters on toadstool poisoning and on cooking fungi. The faults of the book are due mainly to the fact that the style of the author is discursive and confused rather than clear and concise and the temptation to write a large book where a shorter and more accurately scientific treatise would have answered the purpose better has not produced the best result. Although valuable in many ways, it does not seem to us to be so well adapted to the general reader and the student to whom it purports to be addressed as the excellent book of Hamilton Gibson, 'Our Edible Toadstools and Mushrooms.'

A Treatise on Zoology. Edited by E. RAY LANKESTER. Part II. The Porifera and Cœlentera. London, Adam and Charles Black; New York, Macmillan & Co. 1900.

The second volume of the 'Treatise on Zoology,' edited by Professor Lankester, has quickly succeeded the first. It includes an introductory chapter by the editor, followed by a chapter on the 'Porifera,' by Professor E. A. Minchin, and chapters on the 'Hydromedusæ and Scyphomedusæ,' by Mr. G. H. Fowler, and on the 'Anthozoa and Ctenophora,' by Mr. G. C. Bourne. The amount of space occupied by the various chapters is, however, very unequal, Professor Minchin's admirable account of the sponges extending through one hundred and sixty-eight pages, while the Hydromedusæ and Scyphomedusæ together are discussed with only seventy-six, the Anthozoa receiving eighty and the Ctenophores twenty-three.

The introductory chapter by the editor is full of interest as a summing up of the results of the important investigations which he and his pupils have been conducting for many years on the significance of the various cavities known as cœlomic. Lankester recognizes primarily only one form of cœlom, the gonocœl, a space surrounding the reproductive cells, though secondarily it may enlarge and become divided to form cavities surrounding other organs, as in the Vertebrates, for example, in which it forms the pericardial, pleural and peritoneal cavities. In the Arthropods, on the other hand, it becomes very greatly reduced concomitantly with the formation of a hæmocœl, produced by the

distension and fusion of spaces primarily belonging to the vascular system, a method of cœlom-formation to which Lankester applies the somewhat cacophonic term *phlebœdesis*. As a corollary of this view of the cœlom a division into two groups of the organs usually termed nephridia has resulted; those which terminate in a flame cell, such as those characteristic of the Platyhelminths, Rotifers, Chætopods and of certain larval Mollusca, have been placed in one group and retain the original name, while those which stand in relation with the gonocœl or its derivatives, such as those of the adult Molluscs, the Arthropods and Vertebrates, form the second group and are termed uroducts. In passing it may be remarked that we cannot help wondering why, in speaking of nephroblasts on p. 34, the credit for their discovery is assigned chiefly to Bergh, the actual discoverers, Whitman and Wilson, being probably included in the term 'other observers.' Is it possible that Professor Lankester finds his greatest joy in one sinner who repents?

The theory thus briefly outlined has certainly much in its favor, though it must be confessed that doubts are still permissible as to the fundamental distinction between the two forms of cœlom. Final judgment on this point must at all events be postponed until further information as to the developmental history of the cœlomic and vascular spaces of such forms as the Nemerteans and Hirudinea is at our disposal.

In connection with the theory Lankester introduces many new terms, a list of which with definitions forms the concluding section of the chapter. The majority of these are undoubtedly necessary, if the theory be correct, but the terms Enterocœla and Cœlomocœla, used in the heading of the chapter, and proposed as substitutes for the more familiar names Cœlentera and Cœlomata, are certainly open to objection. Perhaps they are more symmetrical than the older terms, but a name, after all, is but a peg whereon to hang an idea, and a superabundance of pegs for one idea is just as confusing as a lack of one, and, furthermore, the term Enterocœlia has already been employed by the Hertwigs for the suspension of a very different idea.

Professor Minchin's chapter on the Porifera is admirable in every respect and fully harmonizes with the excellent work he has previously published upon the group. His treatment of all the points of view is full and accurate, and his discussion of the affinities of the group and the phylogeny of its various subdivisions is clear and suggestive. He inclines to the view of an early separation of the sponges, as the Parazoa, from the remaining Metazoa and maintains the non-identity of the germ layers in the two groups. The chapter, in a word, may be taken as an accurate and comprehensive statement of our present knowledge of this interesting group.

Unfortunately, so much cannot be said without reservation regarding the remaining chapters of the volume. Mr. Fowler's chapters do not evidence the same familiarity with the forms described that is seen in Professor Minchin's work, and the same is true, to a certain extent at least, of Mr. Bourne's contribution. The chapters on the Hydromedusæ and Scyphomedusæ are sketchy, as may be appreciated from the fact that the latter group requires but sixteen pages, or really, if the space occupied by the fourteen figures be deducted, but little more than ten pages. The principal facts concerning the structure and histology of the two groups are given, it is true, but the brevity of style which the author affects leads occasionally to statements which convey erroneous impressions, as, for instance, where it is stated that the threads of the nematocysts 'are formed (*sic*) and lie inside the vesicles,' where delamination alone is given as the method by which the germ layers are formed in the Hydromedusæ, and where invagination is alone given as the corresponding process in Scyphomedusæ. And one misses also some treatment of the broader questions suggested by the structural peculiarities of the group. Thus one finds no discussion of the interesting question as to the origin of the alternation of generations in the Hydromedusæ, so admirably treated by Brooks, nor of the corresponding phenomenon in the Scyphomedusæ, and one searches in vain for any discussion of the phylogeny of the various orders into which the two classes are divided, or for any adequate treatment of the principles underlying the polymorphism so strikingly manifested by the Siphonophores.

In the chapters contributed by Mr. Bourne one finds side by side an admirable treatment of some groups and faulty accounts of others. Thus of the groups in which Mr. Bourne has accomplished admirable investigations, the Alcyonaria and corals, the description is very good, but for the most of the remaining groups the treatment is sadly behind the times. This is especially the case with the forms which he includes under the order Actiniidæ, because so much has been accomplished within recent years in connection with this group, and with these recent advances the author appears to be entirely unfamiliar, basing his classification, as he states, on the work of Hertwig (1882, 1888) and Andres (1383). It is to be remembered that Hertwig's work formed merely the starting point for a reconstruction of the taxonomy of the Actiniidæ, and the progress of the reconstruction has gone on since its publication with rapid strides.

Some excuse, however, may be found for many of Mr. Bourne's taxonomic enormities in the fact that the chapter was evidently written as many as four and possibly even five years ago and has since remained unpublished. But when we read on p. 38 that 'pains have been taken to make it (*i. e.*, the classification of the Zoantharia) as fully as possible representative of the actual state of our knowledge,' and find the volume in which this statement appears dated 1900, we are justified in expecting some record of the results of comparatively recent investigations. Apparently, however, there has been practically no attempt at a revision of the original manuscript, and though Mr. Bourne may not be responsible for the delay in its publication, he may well be held accountable for the failure to bring it up to date.

A detailed criticism of the classification adopted for the Actiniidæ would almost result in a comprehensive review of the entire order, but a few errors may be mentioned in justification of the criticism made above. One finds, for instance, no mention of the family Aliciidæ established by Duerden in 1895, its type, Alicia (Cladactis), being referred to the Bunodidæ; Hertwig's family Liponemidæ is retained and no mention is made of the family Boloceridæ (McMurrich, 1893); the Phyllactidæ are described as belonging to a group possessing foliaceous tentacles, though their foliaceous organs are really highly modified marginal spherules, as was shown by McMurrich in 1893; and Savaglia is suggested as a member of Hertwig's family, Amphianthidæ, although Carlgren showed in 1895 that it is really a Zoanthid. These for samples: a long catalogue of sins both of omission and commission might readily be made, and, naturally, the unfamiliarity with recent work has led to errors of statement in the descriptive part of the work.

With the corals, as stated above, the case is different, though even here the soft parts, so important for the proper understanding of the affinities of the group, are barely mentioned, being dismissed with only six lines of description. And little fault is to be found with the chapter on the Ctenophores, in which an accurate and sufficiently complete description is found, the author deserving especial credit for the stand he has taken against the current but erroneous idea that these forms are Cœlentera or even directly derived from any of the existing Cœlenterate groups.

Attention has been directed in what has been said above, chiefly to the failings of the volume and possibly an erroneous impression as to its general excellence may have been given. It is, nevertheless, a valuable book to place in the hands of the 'serious student' for whom, the preface informs us, it was written, and even though it fails here and there to be an entirely 'trustworthy presentation * * * of the main facts of zoology' it is assuredly worthy of a place on the reference shelf of every zoological laboratory. It may be stated that the illustrations are abundant and, as a rule, excellent, and bibliographic lists and good indices are given at the end of each chapter.

J. P. McM.

Contributions a l'étude des hyménoptères entomophages. Par L. G. SEURAT. Ann. des Sciences Naturelles. Zoologie, X., Nos. 1–3, Paris, 1899. Pp. 1–159. Pl. I–V.

The development of the larvæ of those parasitic Hymenoptera which live within the bodies of other insects has been the subject of much speculation and of some investigation. How these creatures breathe, nourish themselves,

move, molt and pass their excretions, have been mooted points. Cuvier thought that these larvæ breathed by placing their spiracles in relation with those of the host insect. Gerstaecker, in 1863, came to the same conclusion. Ratzeburg attributed a respiratory function to the anal vesicle in certain Braconids and to the caudal appendage in the Ichneumonids. Boisduval concluded that they do not take nourishment through the mouth, that they do not breathe and that they void no excrement, the larva being analogous to the fœtus in mammalia, which lives the life of the mother. Newport described the larvæ of certain Ichneumonids as having no anus, the rectum and its orifice being rapidly developed at the final larval change. The older authors thought that these larvæ attack only the fatty tissues of the host. Bugnion states that Encyrtus nourishes itself exclusively on the lymph. Ganin has observed a curious hyper-metamorphosis in certain egg parasites of the family Proctotrypidæ. Marchal has made some extraordinary observations upon other Proctotrypids, showing that one form (Trichacis) develops in the nervous system of Cecidomyia, while Polygnotus develops in the digestive tract of the same host.

Seurat, in the paper under consideration, reports the results of investigations which he has conducted upon members of three families of parasitic Hymenoptera. He has studied the Braconids, *Apanteles glomeratus* in the common European cabbage worm, *Aphidius fabarum* in the common *Aphis rumicis* and *Doryctes gallicus*, an external feeder on a wood-boring larva. The Ichneumonids studied are two internal feeders, *Mesochorus vittator* and *Hemiteles fulvipes*, and one external feeder, *Xylonomus præcatorius*. Among the Chalcidids he has studied *Diplolepis microgastri*, an internal-feeding hyperparasite in Microgasterid cocoons, and an external feeder, *Torymus propinquus*, which lives in Cecidomyiid galls, feeding externally on the Cecidomyiid larvæ. The work has been done with the greatest care and the conclusions at which he arrives are of authoritative value. They are summarized as follows:

(*a*) *Manner in which larvæ nourish themselves.*—The external and internal larvæ are formed with very sharp mandibles. The internal forms use them in order to pierce the tissue of the host; the external ones to pierce the skin of the host, making a delicate orifice which permits them to suck up the tissues. The digestive tube is always remarkable by the presence of the very voluminous stomach closed behind (this proves to be the rule in the young larvæ of Hymenoptera) and which serves as a sort of storehouse for food which is digested later. A small quantity of food digested at once suffices for the immediate wants of the larva. The voiding of the excrement only takes place in the interior of the cocoon, the stomach not opening until that time. The stomach of the larva contracts and dilates very rapidly, these movements probably favoring the ingestion of food. The materials which the parasite borrows from its host are varied. In certain cases (*Apanteles glomeratus*) the fat, the blood and the lymph only disappear. In the majority of cases the parasitic larva devours everything except the skin and tracheæ. The parasite respects the viscera up to the last limit and only sacrifices them at the end. He has seen in certain cases the larva devour several host insects.

(*b*) *Respiration.*—The problem of the mode of respiration is a puzzling one with internal feeding larvæ. External larvæ are provided with spiracles permitting the entrance of air. The respiration of the young internal larvæ not yet provided with tracheæ filled with air is effected by osmosis through the skin by the whole surface of the body. The larvæ furnished with an anal vesicle or caudal respiratory appendage breathe with the skin of these organs as well as with the whole surface of the body. These appendages are lacking, however, in certain cases, as in the Aphidiinæ, the Chalcididæ, etc. The tracheæ are not slow in appearing elsewhere. The tracheal system is complicated in accordance with the needs of the larva. *It is entirely closed* and the entrance of the air is made through the skin and the very fine membrane of the ultimate tracheal branches. The entire surface of the skin is carpeted with an extremely rich net-work of fine tracheæ which facilitate the accomplishment of this function. The hypothesis of the osmosis of air from the liquid tissues of the host through the body wall of the parasite and the cover of the tracheæ is

not extraordinary. Weismann, having placed the larva of *Musca vomitoria* under water, has seen that the tracheal system remains filled with air at the expiration of several hours. The respiration of internal larvæ is then very normal, the tracheal system having undergone slight modifications. Upon leaving the host the spiracles open and the air enters through them.

(*c*) *Molts.*—He has observed a molt in the young internal larva of *Apanteles glomeratus.* The mandibles and the larval cuticle are shed. In certain of the young larvæ, one sees, in fact, after the molt of the body, the two mandibles of an earlier stage. The molt is made like that of the pupa, the old skin slipping from before towards the anal end of the body. The larva sheds this old skin into the open space behind it.

Such are the facts concerning the mode of life of internal parasites in their hosts. There is really nothing mysterious in this mode of life. The functions are accomplished normally by means of slight modifications which it would have been easy to foresee.

M. Seurat is heartily to be congratulated on this excellent piece of work, setting at rest, as it does, so many mooted points. It is interesting to note that he has not made any observations at all parallel to those of Marchal, who states that a single egg of Encyrtus laid in the egg of Hyponomeuta dissociates itself into a great number of embryos which develop into individual larvæ in the larva of the host.

L. O. HOWARD.

The Structure and Life-History of the Harlequin Fly (Chironomus). By L. C. MIALL, F.R.S., and A. R. HAMMOND, F.L.S. Oxford, Clarendon Press. 1900. Pp. 191; figs. 129.

Professor Miall has gained an enviable reputation as a student of the life history and structure of a number of common insects, and in the course of this work he has discovered many novel and important facts. His little book entitled 'The Structure and Life-History of the Cockroach,' done in collaboration with Alfred Denny, is a model treatise on Orthopteran insect anatomy and his treatise on 'The Natural History of Aquatic Insects' is one of the most valuable and readable entomological books which has been published of late years. In the present volume the authors have given a very careful study of the development of the Chironomidæ, some of the species of which have long been favorite objects with histologists and embryologists. They have a very special biological interest in their various stages and it is thought that their inclusion in ordinary teaching courses will be desirable and will be facilitated by the present volume. *Chironomus* larvæ are very abundant and are found in pools and streams and at the bottom of deep fresh water lakes, Professor S. I. Smith having dredged them from the bottom of Lake Superior at a depth of nearly 1,000 feet. They have also been found in salt water and Packard has studied a species abundant at low water mark in Salem Harbor.

The larvæ inhabit tubes which they make of silk and mud or aquatic vegetation, and certain of the larvæ possess only a rudimentary tracheal system which appears late in the larval stage. No insect known to the writers has more completely departed from the habits and structure of an air-breathing animal, yet even here is found proof of descent from a terrestrial insect with branching air tubes. This remarkable modification is necessary from the fact that certain of the larvæ live at great depths where it is impossible for them to rise to the surface. This absence of a tracheal system does away with the possibility of breathing by tracheal gills which is the commonest respiratory method with aquatic insects and necessitates the presence of blood gills, so that respiration is accomplished practically as with fishes and larval *Batrachea.*

The whole internal anatomy of all stages is carefully described, with excellent figures, and this is done in a masterly and comparative way and includes a study of the embryonic development. An appendix is devoted to the methods of anatomical and histological investigation.

An important point which the authors bear in mind and which Professor Miall has frequently advanced is that they desire by such work to incite the members of naturalist clubs and other non-academic biologists to take up the study of life histories. Such work in the past has yielded facts of the greatest biologic importance, and yet to-day the field is largely

neglected. The great nature-study movement which is making such rapid strides in this country would be encouraged and assisted by many more such books as this if we had the investigators and writers able to make such careful studies and to put them in print in such admirable shape.

L. O. HOWARD.

Transactions of the American Society of Mechanical Engineers. Vol. XXI., New York Meeting, 1899, Cincinnati Meeting, 1900. New York; published by the Society, 1900. Pp. 1778; 8vo., 372 ill.; 33 papers, reports of committees, etc. Printed by J. J. Little & Co.

This large and handsome volume represents the work of the American Society of Mechanical Engineers, so far as it can be exhibited in type, for a single official year. The organization was effected in 1880, after many unsuccessful attempts had been made by other less influential or less tactful members of the profession, and started off with a small number of members selected from among the leaders of the profession of engineering. It now has a total membership of 2,064, including 113 foreign members. The officers are a president, six vice-presidents, nine managers, a treasurer and a secretary, while its governing body, the Council, includes the officers, and the past-presidents of the Society are 'honorary councillors' holding their positions for life or during their continued connection with the Society. Two conventions are held each year, one in New York, at headquarters, the other at usually, some large city in the central or western portion of the country. All persons engaged in engineering are eligible to membership, under certain restrictions and in classes, as members, honorary members, juniors, associates; the Council making a first revision of the list and recommending to the Society those whose credentials are considered satisfactory. The headquarters of the Society are at its own house, No 12 West 31st St., New York City, formerly that of the Academy of Medicine.

The published papers and their discussions cover a very wide range of topics and are supplemented by a series of 'topical discussions' in answer to queries suggested by members and sent out by the Council. These volumes are rich in valuable fact and data thus derived.

The papers are often of considerable length and their value is often proportional to their volume. Thus the report of the Committee of a Standard Method of Steam-boiler Trials, 78 pages, is followed by a discussion occupying 27 pages; Admiral Melville gives 17 pages to 'Engineering in the U. S. Navy'; Thurston on 'The Steam-Engine at the Close of the XIXth Century,' occupies 61 pages; Dr. Eddy on 'Entropy,' submits 17 pages; Laird on a 'Remarkable Steam Pumping Engine Trial,' 24 pages; Goss on a similar work, 39 pages; Robertson on the 'Test of a 125-horse-power Gas-Engine,' covers 43 pages; Herschman on 'The Heavy Automobile,' 30 pages; Kerr's admirable paper on the 'South Terminal Station, Boston,' occupies 27 pages; Professors Cooley and Wagner on a 'Nordbury Engine,' admirably full, 96 pages, while the most generally interesting paper of the volume, apparently, that of Professor Higgins on 'The Education of Machinists, Foremen and Engineers,' 19 pages, is discussed in 86 pages and is supplemented at the second meeting of the volume by another paper, occupying 40 pages, in which the author closes a most extraordinarily interesting and instructive discussion, perhaps the most important and instructive respecting technical education ever yet put in type.

A very large proportion of the papers are devoted to accounts of investigations of the performance of heat-engines and of machinery of interesting, and commonly of novel, character and to descriptions of the processes of experimental research and resultant data. The file of the twenty years past is extraordinarily rich in this, to the engineer, most superlatively valuable material. A large part naturally comes from the technical schools and colleges; but it is always practically valuable and often, if not invariably, conveys a form of knowledge that the practitioner most desires. The fact, however, that the 'practical man' cannot be induced to present oftener, and in good form, the outcome of his experience and the results of his endeavors to secure improved design, to invent new devices and processes,

and to secure more perfect constructions and more permanently valuable operation of his machinery, is lamented in some of the discussions and with good reason; yet it is obvious that this lack is entirely natural; but it is equally obvious that when the technically educated and professionally trained men of the coming generation, now just issuing from the technical and professional schools, to take the lead in the work of the industries of all departments, shall have reached their period of maturity and of maximum usefulness, this difficulty is likely largely to disappear. In fact, the technical papers of the time are coming to more and more illustrate the literary, as well as professional powers of this class.

The illustrations are all well-made, some half-tone, others engraved, many diagrammatic, and constitute a most important feature of the volume. The book-making is excellent and the whole may be taken as among the best, if not itself the very best, of illustrations of the character of the work of the contemporary man of science in these departments of application. The mechanic and engineer of to-day is the maker of the modern material world and it gives the average citizen of every civilized country a feeling of satisfaction and of safety to find that he is at once 'practical' and scientific, experienced and learned, competent to unite the best of scientific knowledge with the richest of technical experience in the design, the construction and the operation of the machinery of the world and in thus building the foundations of our civilization broad and deep and solid. This volume has large significance from the point of view of the economist, the educator, the philosopher and the statesman, as well as from that of the technicist and the engineer.

Its editor, the secretary, deserves cordial congratulations.

R. H. THURSTON.

BOOKS RECEIVED.

Elementary Anatomy, Physiology and Hygiene. WINFIELD S. HALL. New York, Cincinnati and Chicago, American Book Company. 1900. Pp. 273. 75 cents.

Life and Letters of Thomas Henry Huxley. LEONARD HUXLEY. New York, D. Appleton & Company. 1900. Vol. I. Pp. xi + 539. Vol. II. Pp. vii + 541.

The Limitation of Learning and other Science Papers. ALBERT SCHNEIDER. Chicago, Chicago Medical Book Company. 1900. Pp. 100.

Text-book of the Embryology of Invertebrates. E. KORSCHELT and K. HEIDER. New York, The Macmillan Company. London, Swan Sonnenschein and Company. 1900. Vol. IV. Pp. xi + 594. 18s.

One Thousand Problems in Physics. WILLIAM H. SNYDER and IRVING O. PALMER. Boston, Ginn & Company. 1900. Pp. v + 142.

An Elementary Treatise on Qualitative Chemical Analysis. J. F. SELLERS. BOSTON, Ginn & Company. 1900. Pp. ix + 160.

The Progress of Invention in the Nineteenth Century. EDWARD W. BRYN. New York, Munn & Company. 1900. Pp. viii + 476. $3.00.

Die Erdströme im deutschen Reichstelegraphengebiet und ihr. Zusammenhang mit den Erdmagnetischen Erscheinungen. B. WEINSTEIN. Braunschweig, Friedrich Vieweg und Sohn. 1900. Pp. vi + 78 and 19 plates.

Theoretische Betrachungen über die Ergebnisse der wissenschaftlichen Luftfahrten. WILHELM VON BEZOLD. Brunschweig, Friedrich Viewig und Sohn. 1900. Pp. 31.

Über Museen des Ostens der Vereinigten Staaten von Nord Amerika. A. B. MEYER. Berlin, R. Friedländer und Sohn. 1900. Pp. viii + 72.

The Biography of a Baby. MILLICENT WASHBURN SHINN. Boston and New York, Houghton, Mifflin & Co. 1900. Pp. 246. $1.50.

A Reader in Physical Geography. RICHARD ELWOOD DODGE. New York, London and Bombay. Longmans, Green & Company. 1900. Pp. ix + 231.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 329th meeting was held on Saturday evening, December 1st.

L. Stejneger presented a paper 'On Post-Pliocene Migrations of Siberian Animals into Europe,' saying that three invasions of Siberian higher vertebrates into western Europe are distinguishable since Pleistocene times. The first one took place before the maximum glaciation of the ice age, at a time when Ireland and Norway were both connected with Great Britain,

and the latter with France. The second invasion, the so-called 'Great Siberian Migration,' took place after the deposition of the continental boulder day in Central Europe, and the retreat of the glaciers, reaching only England, as Ireland and Norway had become detached by that time. A branch of this invasion reached Scandinavia from the east. The third invasion is still in progress, being most marked and most easily demonstrated along the shores of the Arctic Ocean, entering Scandinavia from the northeast over Finland and northern Russia, a comparatively recent connection between Norway and Siberia. The immigration of a number of birds and mammals into Scandinavia by this route was treated in detail, from both a historical and a distributional point of view.

Erwin F. Smith spoke of 'Sugar Beets in New York and Michigan,' describing the methods of beet cultivation and the various steps in the process of making beet sugar. As many as three hundred acres of beets were raised on one farm, and the daily output of one of the smaller factories was five tons. In theory, the speaker stated, the beet crop was one of the best possible for the land, since by utilizing the waste products of the sugar factory, the potash taken from the soil could be returned to it, but unfortunately in practice this was not done and the waste products, instead of being used, were in Michigan dumped into the streams. Beet diseases, it was said, were already a serious problem, causing serious losses to the farmer, and other diseases would doubtless be introduced from Germany, whence came most of the seed used in this country.

F. A. Lucas.

THE ROYAL SOCIETY.

The report of the Council states according tot he London *Times* that during the past year its time and attention had been largely occupied by business connected with matters of national and international scientific interest, in which her Majesty's Government had either directly sought the advice and assistance of the Society, or had itself given assistance and financial support to undertakings promoted by the Society in the interests of science. The operations of the National Physical Laboratory had been carried on in the buildings of the Kew Observatory. The control of the work carried on by the Kew Committee of the Royal Society was taken over by the executive committee from January 1st, and the property of that committee was made over to the Royal Society from that date. The committee, which was incorporated as a public company, has since been dissolved. The work at Kew Observatory had been continued in all its branches. After considerable discussion, plans for a physics building, at an estimated cost of £6,000, and an engineering laboratory, at an estimated cost of £4,000, were approved by the executive committee and submitted to the general board. Unfortunately, all these plans must be discarded, and very grave loss of time had been caused by the unexpected opposition to the erection of the laboratory in the Old Deer-park. Her Majesty's Treasury had now informed the Council that her Majesty was willing to assign the lease of Busheyhouse and the surrounding ground, thirty acres in extent, for the purpose of the National Physical Laboratory, and that the Government would increase the grant for building by £2,000 in order that the extensive alterations and repairs which would be necessary might be carried out. Though the Council regretted the decision of the Government not to erect the laboratory in the Deer-park, they recognized with gratitude that her Majesty had been graciously pleased to place at the disposal of the Society a site in which the work of the laboratory could be carried on, and they had, therefore, accepted the offer made to them by her Majesty's Treasury. The committee had to thank various donors for gifts. Sir Andrew Noble had contributed £1,000 for the purchase of apparatus. Dr. Isaac Roberts had given a spectroscope and two very valuable induction coils. Dr. Common had provided apparatus for determining the magnifying power and testing

* 'The Principles of Stratigraphic Geology,' by J. E. Marr, 1898, p. 98.

† See *Bull. Amer. Paleont.*, No. 13, November, 1900. Ithaca. 26 pp., 5 pl. Describes twenty new species of calciferous Gastropoda, Brachiopoda and Trilobites; also one new genus of Trilobita, all from the Mohawk Valley, usually considered unfossiliferous.

the collimation error of the telescopic sights, and had promised a large flat surface for optical work. Mrs. Sworn had given two thermometers (used by her late husband). The report dealt also with the disturbance of magnetic observatories by electric railways, the steel rails committee, and the national Antarctic Expedition. With respect to the latter it was stated that the commander of the expedition, Commander R. F. Scott, R.N., the head of the scientific staff, Professor Gregory, and three other officers had been appointed, and it was confidently hoped that the expedition would be ready to start by August, 1901, when the German Antarctic Expedition was also expected to sail. Funds had been raised exceeding £91,000, including the grant from her Majesty's treasury of £45,000. This fund was raised in view of an expedition lasting two years, but appeals were being made for more funds to enable the expedition to remain in the Antarctic for three years, for which the sum of £120,000 was required. The report also dealt with malaria, into which the results of the investigations had now been published in part. Other subjects were the 'Solar Eclipse of May 28, 1900,' and the 'International Catalogue of Scientific Literature,' on which considerable progress had been made. Her Majesty's Government had guaranteed £1,000 a year for five years, 'to make good to the Royal Society a part of any loss which might be incurred by the publication of the proposed catalogue.' At the International Association of Academies, the first meetings of which were held at Paris on July 31 and August 1, 1900, the Royal Society was represented by Professor Rücker. As matters at present stood, the Royal Society being regarded as a scientific society only, the United Kingdom could only be represented on the scientific section of the Association. With respect to the Mackinnon Bequest it had been decided that the award should be in the nature of a studentship for the encouragement of research rather than a prize for the reward of past achievement, and tha the studentship (which at present amounted to about £150 per annum) should be devoted to the maintenance of a student engaged in research. Under the will of the late Professor Hughes, a bequest of £4,000 had been made to the Royal Society with a direction to award the income annually as a prize either in money or in the form of a medal, or partly one and partly the other, for the reward of original discovery in the physical sciences, particularly electricity and magnetism, or their applications, the prize or medal to be given under conditions to be fixed from time to time by the Society on lines similar to those followed in the bestowal of the Copley, Rumford and Royal medals. The report also dealt with terms of bequest, the apartments of the Society, electric lighting, the library, publications, the publication fund, the catalogue of scientific papers, the Government grant, general business and the presidency.

THE HARTMAN ANTHROPOLOGICAL AND ARCHEOLOGICAL COLLECTION.

THERE has just been exhibited at Stockholm a fine collection of archeologic and ethnographic objects from Central America, made by Dr. C. V. Hartman (formerly naturalist of the Lumholtz Expedition to North Mexico) at the instigation and expense of Engineer Åke Sjögren. In a short guide to the exhibition by Dr. Hj. Stolpe, we are told that Dr. Hartman began his researches in 1896 at Mercedes, where he discovered a large workplace for the manufacture of stone gods and other antiquities of unusual interest. Among those now exhibited are two standing figures of stone, the largest as yet brought to Europe from Central America, which were erected at the east end of a large oval tumulus, about 300 feet in circumference and covered with stone to a height of 22 feet. East of this was a rectangular court, walled with stone on three sides, with a cairn of about 90 feet in circumference and 12 feet in height in each of its eastern angles; and on the flat tops of these lay fragments of smaller statues. Afterwards Dr. Hartman went up to the high plateaux of the interior and investigated many cemeteries, especially those of Orosi, Chiricot (3,000 feet above sea level), Lemones and Santiago. The graves were examined in the most exact and scientific manner, such as had never before been attempted in these parts, and a foundation was thus laid for a chronological grouping of

Central American antiquities. In all, over 400 graves were opened, and showed a typical stone-age culture; no weapon or cutting tool of bronze, still less of iron, was found. But though the majority of the graves were uninfluenced by European culture, proof was not wanting that in two cases cemeteries at Orosi and Mercedes were in use after the Europeans had reached the New World. In a grave at Orosi were found some mosaic glass beads, clearly of Venetian origin, and in a grave at Mercedes was a large bead of blue glass. Another valuable contribution to the chronology of the find is afforded by a clay bowl found at Salvador, and bearing Maya hieroglyphs, which probably denote the number of a year according to their chronology, which unfortunately has not yet been connected with that of the Old World.

Similar explorations were carried out in the Guanacaste peninsula on the Pacific coast, and on the islands in the bay of Nicoya, also at Carrizal on the neighboring mainland. Dr. Hartman then proceeded to Salvador, where for nearly a year he dwelt in one of the largest villages inhabited by the Pipilas, an Aztec tribe, and devoted himself to the study of their manners and customs, and religious ideas and language. Here he made a rich ethnographic collection, also a collection of Indian antiquities from the neighborhood, and compiled the first vocabulary of a Central American Aztec dialect that has any pretence to completeness. He also made an anthropometric examination of 100 Aztec individuals, and took a number of photographs.

In Guatemala Dr. Hartman visited the Indian tribes, Cakchiquels, Zutujils, Quichés and Xincas, as well as the Huavas on Cape Tehuantepec in southern Mexico. His notes on the language of the last two are of the greatest interest, inasmuch as there was previously no material for the classification of their tongue. Here also may be mentioned a test of the so-called nahuatlisms, remains of the ancient Aztec language which have been adopted in the Spanish now spoken in those regions.

Dr. Hartman returned to Sweden in October, 1899, bringing the valuable collections now exhibited, which Mr. Sjögren, with great generosity, has handed over to the Ethnographic Museum of the State.

THE GROWTH OF CITIES.

A RECENT census bulletin contains reports on the population of cities having 25,000 inhabitants, or more, in 1900. There were 159 of these cities which are placed in four groups according to their size. The increase in population from 1880 to 1900 is shown in the following table:

CLASSIFIED SIZES.	No.	POPULATION.			INCREASE FROM 1890 TO 1900.		INCREASE FROM 1880 TO 1890.	
		1900	1890	1880	Number.	Per cent.	Number.	Per cent.
Totals	159	19,694,625	14,855,489	9,933,927	4,839,136	32.5	4,921,562	49.5
Cities of 200,000 and over	19	11,795,809	8,879 105	6,311,653	2,916,704	32.8	2,567,452	40.6
Cities of 100,000 and under 200,000	19	2,412,538	1,808.656	1,009,163	603,882	33.3	799,493	79.2
Cities of 50,000 and under 100,000	40	2,709,338	2 067,169	1,368,309	642,169	31.0	698,860	51.0
Cities of 25,000 and under 50,000	81	2,776.940	2,100,559	1,244,802	676,381	32.2	855,757	68.7

The 19 largest cities are further classified as follows:

CLASSIFIED SIZES.	No.	POPULATION.			INCREASE FROM 1890 TO 1900.		INCREASE FROM 1880 TO 1890.	
		1900	1890	1880	Number.	Per cent.	Number.	Per cent.
Totals	19	11,795,809	8,879,105	6,311,653	2,916,704	32.8	2,567,452	40.6
Cities of 3,000,000 and over	1	3.437,202	2,492,591	1,901.345	944,611	37.8	591.246	31.0
Cities of 1,000,000 and under 2,000.000	2	2,992,272	2,146,814	1,350,355	845,458	39.3	796,459	58.9
Cities of 500,000 and under 1,000,000	3	1,645,087	1.334,686	1,045,670	310,401	23.2	289.016	27.6
Cities of 300,000 and under 400,000	5	1.724,455	1,351,539	960,767	372,916	27.5	390,772	40.6
Cities of 200,000 and under 300,000	8	1,996,793	1,553,475	1,053,516	443,318	28.5	499,959	47.4

The cities of over 1,000,000 should, however, be separated, Chicago having had an increase of 54.4 per cent. and Philadelphia of only 23.5.

HARBEN LECTURES ON THE PLAGUE.*

THE first of the three Harben Lectures for 1900 was delivered at the Examination Hall of the Royal Colleges of Physicians and Surgeons, London, on November 7th, by Dr. A. Calmette, Director of the Pasteur Institute of Lille. After a short reference to the history of plague, he said it was possible for him to bring forward some modern views of the disease from his recent researches made as the result of his mission to Oporto last year with Salembeni. After giving a description of the plague bacillus, Dr. Calmette said plague assumed two principal clinical forms, bubonic plague, and plague without buboes. After describing the symptoms of plague he showed that the localization of the lesions in the gland determined the special attitude of the patient. The forms of the plague without bubo occurred more rarely than the classical forms of bubonic plague. Primary pneumonic plague was evidently due to the penetration of the microbe into the respiratory channels. It could be diagnosed only by bacteriological examination of the sputa, because the aspect of the sputum, the clinical symptoms, and the auscultatory signs resembled those of ordinary pneumonia. Another and still rarer form of plague without buboes was septicæmic plague or pesticæmia, which developed with extreme rapidity like acute septicæmia. It was caused by the rapid growth of the plague bacillus in the blood and in all the organs. It was not exactly known where the virus first effected an entrance in these cases, but the hypothesis was that it penetrated by the gastro-intestinal tract. When plague was studied in an epidemic center all the forms described were met with, but sometimes it happened that the first cases did not present such clear characteristics, and it was thus possible that they might be incorrectly diagnosed. At the commencement of a case of bubonic plague, that is to say, at the period when there was only glandular congestion and fever, to ascertain whether the plague microbe was present or not, a puncture should be made with a Pravaz's syringe into the lymphatic tissues, and some drops of fluid extracted. This could be inoculated in the usual manner and examined immediately after staining. To put the patient beyond the danger of any possible re-infection, it was only necessary, directly after the puncture with the syringe, to inject about 5 c.cm. of antiplague serum into the middle of the gland or at a short distance from it. If on examination of the fluid the microbes were found free and very numerous, the prognosis was serious; if the microbes were nearly all enclosed in polynuclear cells, it might be hoped that the case was non-malignant and that the infection would remain localized. It was essential, in testing the virulence of a plague microbe by experiments on animals, to use a recent culture, not older than twenty-four to forty eight hours at the most.

Mice, rats and guinea-pigs were very susceptible to plague, but it was thought that many other animals could take the plague. In this respect the pig, the ox and poultry had been mentioned, but these animals did not take the disease spontaneously. Birds were not easily infected by plague bacillus; the vultures on the Towers of Silense near Bombay suffered no ill after devouring plague corpses, but it was not proved that they did not scatter the plague microbe with their excreta on the surface of the soil. The monkey easily contracted plague by inoculation, and also spontaneously when placed in a cage side by side with another infected monkey. The bacilli could also be transported by fleas, by the other parasites of the skin and by flies. Healthy mice placed in the same cage with infected mice, but separated by wire, so that they could not touch each other, contracted the plague at the end of a few days; the contamination in these cases was due to fleas and flies. Professor Calmette illustrated his lecture with lantern slides, depicting patients affected with plague.

* From the *British Medical Journal*.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR W. W. CAMPBELL has been appointed director of the Lick Observatory in succession to the late Professor James E. Keeler.

ON account of failing health Dr. Edward von Mojsisovics is retiring from the post of vice-director of the Geological Survey of Austria, into which body he entered as a volunteer on February 18, 1865, the director then being W.

von Haidinger. Dr. von Mojsisovics now hopes to bring to a more speedy conclusion his great works on the Cephalopoda of the Hallstätt limestone and on the geology of the Salzkammergut. All future communications should be addressed to him: Wien, III/3. Strohgasse Nr. 26.

The American Society of Naturalists and eight affiliated societies, devoted to the natural sciences, will, as we have already announced, meet at the Johns Hopkins University, beginning on Thursday, Dec. 27th. The proceedings of the Society of Naturalists are as follows: An address of welcome will be made by President Gilman on Thursday evening, followed by a lecture by Dr. Frank Russell, of Harvard University, on 'Indians of the Southwest,' and a reception in McCoy Hall. The annual discussion, which takes place on Friday afternoon, is on 'The Attitude of the State toward Scientific Investigation,' and the speakers are Professor H. F. Osborn, Columbia University; Professor W. B. Clark, Johns Hopkins University; Dr. L. O. Howard, chief of Division of Entomology, Washington, D. C.; Mr. B. T. Galloway, director of Plant Industry, U. S. Department of Agriculture and Professor W. T. Sedgwick, Massachusetts Institute of Technology. The address of the president, Professor E. B. Wilson, of Columbia University, will be given at the annual banquet on Friday evening. The headquarters of the Society are at Hotel Rennert.

The fourth annual meeting of the Society for Plant Morphology and Physiology will be held, with the American Society of Naturalists and the Affiliated Scientific Societies, at Johns Hopkins University, Baltimore, Md., on Thursday and Friday, December 27th and 28th, 1900. The usual social meeting will be held on Wednesday evening, December 26th. Among the special features of the meeting will be the presentation and discussion of an important report of the committee appointed to consider methods of securing improvements in reviews of current botanical literature, and two special lectures upon subjects of contemporary interest, one by Dr. Erwin F. Smith on 'Bacterial Diseases of Plants,' and one by Professor G. F. Atkinson, on 'Cytological Problems connected with Fertilization.' The address of the President, Professor D. P. Penhallow, will discuss 'A Decade of North American Paleobotany.' An excursion of the Society to Washington, to visit the United States Department of Agriculture, is planned for Saturday morning, December 29th. Further information about the meeting, and copies of the provisional program may be obtained from the Secretary, Professor W. F. Ganong, Northampton, Mass.

The Society of American Bacteriologists, organized at New Haven, in 1899, will hold its second annual session at Baltimore, in connection with the American Society of Naturalists, December 27th and 28th. The meetings will be held in the Pathological Laboratory of the Johns Hopkins Hospital. All interested in bacteriology, whether members of the Society or not, are cordially invited to attend the meetings. A program has been prepared which will occupy three sessions. A 'smoker' will be held on Wednesday evening at ten o'clock, at which time will be given the presidential address by Professor W. T. Sedgwick.

The other societies meeting with the Naturalists, to the arrangements of some of which we have already called attention, are: The American Morphological Society, The Association of American Anatomists, The American Physiological Society, The American Psychological Association, The American Folk-Lore Society, the Section of Anthropology of the American Association for the Advancement of Science.

The thirteenth winter meeting of the Geological Society of America will be held at Albany, N. Y., beginning on Thursday, December 27th, in the Chapel of the Albany Academy. The Council will meet at 9 o'clock on Thursday morning; the Society will be called to order by President Dawson at 10 o'clock. The president's address will probably be given on Thursday morning, and the subscription dinner will take place in the evening.

The twenty-second general meeting of the American Chemical Society will be held in Chicago, Ill., December 27th and 28th, 1900. Elaborate preparations have been made for it, and the meeting is sure to be successful. Plans are

being made for celebrating on April 6, 1901, the 25th anniversary of the foundation of the Society.

PROFESSOR E. DANA DURAND, of Leland Stanford University, has been appointed secretary of the U. S. Industrial Commission.

MR. MERRITT LYNDON FERNALD, assistant in the Gray Herbarium of Harvard University, has recently been elected a fellow of the American Academy of Arts and Sciences.

DR. WESLEY MILLS, professor of physiology at McGill University, spent last year in Europe and was the guest of Professors His, Held and Flechsig, more especially while conducting researches on the nervous system. He returned in the latter part of September, and is devoting himself largely to the problem of the equipment of the new laboratory and the rearrangement of the courses in his subject.

IT is rumored that Mr. J. H. H. Teall will shortly succeed Sir Archibald Geikie as director of the Geological Survey of Great Britain and Ireland, and that Mr. C. Lapworth will be appointed to the chair of geology in University College, London, vacant by the resignation of Professor T. G. Bonney.

Nature reports that the government of Jamaica is obliged to retrench in the work of the Museum, necessitating the discharge of the curator, Dr. J. E. Duerden. Dr. Duerden has carried on important investigations in marine zoology, and the cessation of his work will cause regret amongst all zoologists.

A GENERAL committee is being formed to arrange a memorial of the late Professor Henry Sidgwick of Cambridge University. It may be remembered that Professor Sidgwick several years ago requested that his salary as Knightbridge professor of moral philosophy be reduced from £700 to £500 per annum, the reduction to continue until 1902. Mrs. Sidgwick has, in accordance with Professor Sidgwick's wish, contributed this year £200 and will do the same next year to carry out Professor Sidgwick's subscription for the benefit of the University.

WE regret to record the death of Professor Marshall Henshaw, formerly professor of physics and astronomy at Rutgers College and later lecturer on physics at Amherst College, and of Dr. S. Hoepfner, consulting engineer and chemist, of Hamilton, Ont.

THE Samuel D. Gross prize of $1,000, of the Philadelphia Academy of Surgery, was not awarded this year, as suitable contributions were not received, and the time has been extended to October 1, 1901. The prize is awarded every five years to the writer of the best original essay, not exceeding 150 printed pages, octavo, in length, illustrative of some subject in surgical pathology or surgical practice, founded upon original investigations, the candidates for the prize to be American citizens.

IN connection with the Geological Survey of Iowa, now in progress, Professor Macbride is attempting to present to the people of the State an accurate account of their all too slender forest resources. Appended to the report of the geology of each county, appears an annotated list of the arboreal species of plants found within the same limits, with special reference to the economic value of the several species and recommendations for the aid of farmers and others who may attempt tree-planting on an extensive scale. The latest issues are reports on Osceola, Dickinson and Dubuque Counties.

UNDER the auspicies of the Department of Agriculture and Technical Instruction for Ireland, the following demonstrations are to be given during the winter at the Dublin Museum: On 'Crocodiles, Snakes and Lizards,' and on 'Turtles and Tortoises,' by R. E. Scharff; on 'Lemurs and Monkeys,' and on 'Apes and Men,' by G. H. Carpenter; on 'Crabs and Lobsters,' by W. A. Cunnington; on 'Irish Sea-fishes,' and on the 'Economic Products of the Sea,' by A. Nichols; on 'Irish Shore and Sea-birds,' by C. J. Patten; on 'Flax-dodder and other Parasitic Plants,' and on 'Botanical Specimens for School Teaching,' by Professor Johnson; on 'The First Use of Metal in Europe,' by Mr. Coffey; on 'Writing Materials in Olden Times,' by Mr. Lyster; on 'Lace,' by Mr. Brenan; on 'Engraving,' by Mr. Strickland; on 'Clocks and Watches,' by Mr. Johnston; on 'Dutch XVIIIth Century Faience,' by Mr. Alabaster; on some objects from the Paris Exhibition,

and on 'How to Visit a Museum,' by Colonel Plunkett, the director of the Museum.

THE Ohio State Academy of Science holds its tenth annual meeting at the Ohio State University Biological Hall, Columbus, Ohio, on December 26th and 27th, 1900.

THE usual December meeting of the New York Association of Biology Teachers was held, by invitation, at the Teachers College, Columbia University. The address of the evening was made by Professor F. E. Lloyd, the subject being 'Biological Exploration in the Mississippi Delta and Adjacent Islands.' At the close of the address an informal reception was held in the Laboratory of the Department of Biology.

AT a meeting of the Botanical Section of the Academy of Natural Sciences of Philadelphia, held on December 10, 1900, the following officers were elected: *Director*, Thomas Meehan; *Vice-Director*, Geo. M. Beringer; *Treasurer* and *Conservator*, Stewardson Brown; *Recorder*, John W. Harshberger; *Executive Committee*, Geo. M. Beringer, Thomas Meehan, Stewardson Brown, Jos. D. Crawford, Ida A. Keller.

THE next meeting of the Pan-American Medical Congress, over which the late Dr. William Pepper was to have presided, will be held at Havana from February 5th to 9th, 1901.

THE British Medical Association will hold its 69th annual meeting at Cheltenham from July 30th to August 2d, 1901: The 'Presidential Address' will be delivered by George Bagot Ferguson, M.D. The 'Address in Medicine' by James F. Goodhart, M.D., LL.D., consulting physician, Guy's Hospital. The 'Address in Surgery' by Sir William Thomson, M.D., LL.D., surgeon to the Richmond Surgical Hospital, Dublin, and surgeon in ordinary to the Queen in Ireland. The scientific business of the meeting will be conducted in thirteen sections. The names of the sections are as follows: A.—Medicine. B.—Surgery. C.—Obstetrics and Gynæcology. D.—State Medicine. E.—Psychological Medicine. F.—Anatomy and Physiology. G.—Pathology and Bacteriology. H.—Ophthalmology. I.—Diseases of Children. J.—Laryngology and Otology. K.—Tropical Diseases. L.—Navy, Army and Ambulance. M.—Dermatology.

PROFESSOR F. E. NIPHER, of St. Louis, writes that after many months of failure, he has succeeded in developing a fine reversed picture on the Cramer 'crown' plate, with the developing bath fully exposed to direct sunlight. The operation lasted a full half-hour, with no trace of fog. The details showed through the plate long before they came out sharply. The developer was a modification of the hydrochinone, the formula for which is given in every box of the Cramer plates. The bromide was left out, and the sodium carbonate solution was made up at half the strength used for negatives. The mixed developer was diluted with water in the proportion of one part to nine. This result is certain greatly to reduce the camera time.

A REPORT on the agricultural conditions of Porto Rico, transmitted to the House of Representatives by the President, on December 10th, recommends that an experiment station be established there. Secretary Wilson advises an appropriation of $15,000 to establish it, with an annual appropriation of $15,000 for maintenance.

A CURIOUS epidemic of neuritis has been afflicting many in the north of England, and (in spite of the fact that some teetotalers have suffered) has been traced to beer-drinking. The best founded opinion seems to be that which assigns it to the cheap sugar used in 'priming' the beer, since the sulphuric acid used in its manufacture is made from iron pyrites and contains traces of arsenic. Whatever may ultimately be fixed on as the deleterious agent, there will be an outcry for a return to malt and hops.

THE London *Times* reports that in addition to the British Antarctic expedition, there is also one in preparation in Sweden under the leadership of Dr. Otto Nordenskjöld, the well-known savant, who was a member of the Danish expedition to East Greenland last summer under Lieutenant Amdrup. Dr. Nordenskjöld has also shared in several Swedish polar expeditions. For the purpose of his Antarctic expedition he has acquired, for a nominal sum, the steam-whaler the *Antarctic*—an appropriate name—in which the Greenland voyage was performed. This vessel has quite an historical

Arctic record. It was built for whaling in the Greenland seas by a Norwegian firm, and has performed many voyages in polar waters. She was eventually acquired by Professor G. Nathorst, the celebrated geologist and Arctic voyager, who has shared in almost every Swedish polar expedition. Last year, again, the *Antarctic* was employed in the search for Andrée on the east coast of Greenland, when the owner himself was in command of the expedition, but which yielded no result. The vessel has thus again passed into Swedish hands. She was also engaged in an earlier voyage to the seas whence she derives her name by Norwegian speculators with the hope of reopening the famous whale fisheries in these parts, but the enterprise was an utter failure, not a single sperm whale being even seen. The vessel, which is in splendid condition for navigation in the pack-ice, and is, in fact, especially built for that purpose, will now proceed to Gothenburg for her final equipment. As she has cost so little Dr. Nordenskjöld estimates the cost of the expedition at only some £10,000 more. Of this sum one-half has already been contributed by Swedish subscribers, and King Oscar, with his well-known interest in Swedish explorations, has also promised a considerable amount towards the expedition, the first of its kind ever despatched from Sweden. Should circumstances permit, the Swedish expedition will, of course, cooperate with the British and German. It is hoped that the *Antarctic* may be ready to sail next August.

THE sculptured decoration for the pediment above the four main entrances of the Ethnological Building at the Pan-American Exposition at Buffalo, is being modeled by Mr. H. A. MacNeil to represent the study of American ethnology. The original plan, suggested to him by Mr. Harlan I. Smith of the American Museum of Natural History, was to represent the inhabitants of the four quarters of North America and bring out the influence of the special environment of each. The idea was to represent upon the northern pediment the Eskimo, with his snow house, spliced bone arrow shafts, skin clothing and kayak, in a country barren of vegetation; upon the eastern pediment the Algonkin with snow-shedding steep-roofed bark hut, with canoes of wood or birch bark in a stream bordered by wild rice and forest; on the west the Kwakintl, with split plank house of immense size, with grotesquely carved totem pole, in a country of fog, rain and luxuriant vegetation; on the south the Zuni in a desert country, where steep roofs were unnecessary, but where pottery for carrying water reaches a high development. This plan had to be modified as the appropriation was for one model only and Mr. McNeil, in his desire to show something typically American, as contrasted with the usual classic decoration employed in museum architecture, and to represent the study of American peoples, has chosen two reclining emblematic figures, a woman on the left holding a pottery vessel and on the right a man in the act of measuring a human skull. These represent the study of man and his arts. Between these is a shield and a bird whose raised wings border it. This is emblematic of the food and clothing of the North. At the base are designs suggesting the highest culture of the South. In the lower right-hand corner is the prow of a birch bark canoe typifying the eastern Indian. These represent the environmentand materials for the study of American ethnology.

THE first ordinary meeting of the Royal Geographical Society in the session 1900–1901 was held on November 12th, when Dr. A. Donaldson Smith read an account of his expedition through Somaliland and between Lake Rudolf and the Nile. Sir Clements Markham, president of the Society, occupied the chair, and in his introductory address, said, according to the London *Times*, that the most important geographical event since the close of the last session had been the return of the expedition of the Duke of the Abruzzi from Franz Josef Land. He had the great merit of having personally organized and fitted out the expedition in every detail, and an expedition had seldom sailed which had been so carefully and thoroughly equipped. Its geographical results were of great importance, for it had finally discovered the northern limits of the Franz Josef group, and confirmed Nansen's discovery of a deep ocean to the north; while the sledging party under Captain Cagni reached the highest northern latitude yet attained. If it could be ar-

ranged, the Duke of the Abruzzi would be pleased to give the Society an account of his expedition in the course of the session. The Danish expedition to East Greenland had also returned, after successfully continuing the work of Dr. Nathorst last year, while a Norwegian whaler was able to follow the coast of 75° 30′ N. Thus the dotted line which had so long indicated the supposed position of the East Greenland coast on our maps would now give place to a definite surveyed line, thanks chiefly to the persevering efforts of Danish geographers and explorers since the days of Graah. News of the expeditions of Sverdrup and Peary up Smith Sound was still anxiously awaited. The *Windward* went out to bring them succor, but she had not yet returned. The two recent expeditions to the Antarctic regions had both supplied us with valuable information. The British Antarctic expedition was now, at last, making progress as regards equipment and other arrangements. The ship was in an advanced state. Captain Scott, R.N., the commander of expedition, was only able to take charge last August, but he had already shown that he possessed many of those qualities which were essential for so difficult and responsible a post. The German expedition was far more advanced than the British in every department of its work, under the direction of its able and accomplished commander, von Drygalski; but this was because his committees had seen the wisdom of giving him a perfectly free hand. The commanders of the two expeditions had had an opportunity of becoming friends and of exchanging views during the autumn, and Captain Scott, if not too much trammelled by committees, would soon make up for lost time. Dr. Sven Hedin had during the past year been actively at work in the Lob-nor country and the basin of the Tarim, and his archeological discoveries would throw a flood of light on the past history of that region. In Africa the greatest amount of geographical work had been done this year. But a review of it must, alas! commence with a reference to the loss of a valued explorer. It was only last session that Captain Wellby's father read the account of his gallant son's splendid geographical achievement in marching from Abyssinia to the Nile. All would remember how they looked forward to welcoming him on his return from the front. Now that could never be. Captain Wellby had fallen fighting for his country. It was a glorious death, fitting close of an adventurous and active life. We were left to mourn the death of a young officer who was a great explorer and an ornament to the army. His noble example had been followed by others; for there had been remarkable activity in the exploration of Africa this year. Major Gibbons had followed Mr. Grogan from the Cape to Cairo. Mr. Moore had returned after his important investigation of the Central African lakes. Mr. Harrison had brought home an admirable map of the region between Lake Rudolf and Adis Abeba. The Society's gold medalist, M. Foreau, had safely returned after his wonderful journey across the Sahara, of which he had promised to send some account. Last, but certainly not least, Dr. Donaldson Smith, who was an old friend and known to all from his previous work, had made very remarkable journeys, involving new discoveries between Lake Rudolf and the Nile. He was glad to learn that serious steps had been taken under the Intelligence Department to carry out administrative surveys of all those territories in Africa which were directly dependent on the home Government, and that in conjunction with the other European powers which had African possessions.

Artists and art critics often claim that modern industrial conditions are unfavorable to the fine arts. In order to show that a more correct view is held in some quarters we quote the following note from the New York *Evening Post:* M. Arsène Alexandre, the well-known critic of art, discovered the much-talked-of *art moderne*, at the Paris Exposition, where one would least expect it to be—in the exhibit of locomotives. What appeared in a novel and striking light was not merely that these great machines had a beauty of line and proportion all their own, but that they showed a distinct beauty of racial type. The national character was clearly marked, in an American locomotive as distinguished from a French, a German or an English locomotive, and so of each as regarded the others. The critic found in the American

machine a combination of elegance, practicality, convenience and power, which betokened a race that takes its ease in working. The English machine was more trim and smug, smaller, too, though with no loss of power; the German, similar, but a shade more pompous; the French, lighter and finer in line, but less powerful and effective. So as to the Russians, the Italians, and the Austrians, each locomotive not only had a beauty of its own, but was an impressive symbol of the national character. Returning after this voyage of exploration to the great international exposition of painting, M. Alexandre found a pervading sameness—most of the pictures might have been done in Rome, in Brooklyn, in Munich or in Paris, indifferently. It all seemed factitious—the output of a small international cult, not of great nations. The genuine art of the day was not here, but with the locomotives. The lover of art in its traditional forms will subscribe most reluctantly to M. Alexandre's allegory of the future of art. Yet no one can withhold a sentiment of admiration for this bold theory that the art of the future must grow unconsciously out of its most vital interests—not out of the fine arts in the traditional sense, but out of science and industry.

THE British Consul at Stuttgart, in a report abstracted in the London *Times*, gives some interesting particulars respecting the growth of the acetylene gas industry, which he describes as one of the triumphs of German scientific industrialism. Five years ago calcium carbide was known only to trained chemists as an interesting chemical compound, and was quite unknown to the public. Now its production is one of the most important chemical industries. Germany was foremost to recognize the new illuminant, and it has secured the principal place in its production. At present there are at least 200,000 jets of acetylene gas in use in the country, and it is, the consul says, impossible to predict the result of the competition between it and its rival illuminants. Probably petroleum will suffer most; coal gas will be superseded to a great extent, especially in lighting small towns, but electricity will not be appreciably affected. No other branch of industry can point to such a large and steady increase in the number of patents, showing that it has encouraged great fertility of invention. Besides producing it at home, German capitalh as gone abroad to produce carbide, especially to Norway and Switzerland. One of the greatest successes of the industry has been its application to the lighting of railway carriages on German Government lines. During the current year the consumption of carbide in the country is estimated at 17,000 tons, equal in illuminating power to about seven millions of gallons of petroleum. Thirty-two small towns, with populations up to 5,000, are lighted by acetylene, and many more contemplate its adoption; and the progress of the system of lighting, says the Consul, is 'another striking instance of the manner in which the magnificent system of technical education has prepared the way for the introduction of new scientific achievements.' The economic importance of the industry appears from the fact that Germany annually pays about five millions sterling to the United States for petroleum, while acetylene is a purely German industry, carbide being manufactured in the country, which possesses in various parts all the necessary raw materials.

PROFESSOR E. HITZIG delivered on November 29th the second Hughlings Jackson lecture before the London Neurological Society. According to the London *Times* he discussed the present position of scientific knowledge concerning the psychical functions of the different parts of the surface of the brain. Since the experimental discovery in 1870 by the lecturer that a portion of the surface of the brain is divisible into separate areas or centers, each of which initiates and controls the movements of the various divisions of the body, many investigators had endeavored to solve the important questions, first, whether such areas or centers are really distinct psychical organizations, and, second, how such miniature psychical mechanisms act in relation to the phenomena of voluntary and automatic reactions respectively. A summary of the researches which have been made during the last thirty years establishes the truth of the view that such centers really exist, and that we now know definitely the precise spot in the brain which actively causes the movement of an arm and hand, for

instance, when a voluntary action such as writing or drawing is executed. To students of psychology the further problem to be solved is how such centers act in relation to each other, and, above all, how far they are organizations for the reception of sensory impressions, as well as stations which issue outgoing orders, as it were, to the muscles. It is universally admitted that apperception must immediately precede all acts of so-called volition. This question the lecturer regarded as answered by the view that, at least in the carnivorous animals, brain conceptions and ideas of the movement to be performed by any part of the body are represented in the so-called motor center, which unquestionably is the starting point from which the final nerve impulse for the execution of that movement issues. After referring to the degree in which Dr. Jackson's original deductions have been confirmed by subsequent physiological as well as clinical investigations, Professor Hitzig dwelt on the fact that all workers in science are united in one camp in the battle against ignorance and against the opposition which some offer to the progress of natural knowledge. He felt that the invitation to him as a foreign investigator to deliver this lecture was an honorable expression of their common interests in their science.

UNIVERSITY AND EDUCATIONAL NEWS.

A CIRCULAR letter issued by the Yale Bi-centennial Committee states that besides conditional pledges of $250,000, subscriptions to the amount of $900,000 have been received since the bi-centennial movement was started.

FIRE in the main college building of the Iowa State College of Agriculture and Mechanic Arts destroyed on December 8th a large amount of valuable botanical material. The Parry herbarium was saved, except the duplicates which were nearly all burned. A part of the grass collection was saved and a few of the other specimens. The general collection contained about 80,000 specimens; more than 50,000 of these were burned, besides a large number of duplicate specimens numbering many thousands. Many valuable western plants collected by the writer, representing four years of labor, were destroyed. Also sets of plants from Porto Rico, Cuba, Mexico, Wyoming, Colorado and Texas were burned and much of the private library was also ruined, as well as the department library. Most of the microscopes and other apparatus were burned. Manuscript on grasses of the State, besides one on thistles and some smaller papers ready for publication, were also destroyed.

MYRON L. FULLER, S.B., formerly instructor in geology at the Massachusetts Institute of Technology, is now an assistant geologist in the United States Geological Survey. He has been spending the summer in association with Mr. M. R. Campbell in the coal fields of western Pennsylvania, Ohio and Indiana. Charles H. Warren, Ph.D., has been appointed instructor in mineralogy and geology at the Institute in the place formerly occupied by Mr. Fuller. Dr. Warren was previously instructor in Professor S. L. Penfield's Laboratory in New Haven.

MR. JOHN SEALY TOWNSEND, M.A., fellow of Trinity College, Cambridge, lecturer and demonstrator in the Cavendish Laboratory, has been appointed to the newly-established Wykeham professorship of physics at Oxford. Professor Townsend, as we learn from the London *Times*, was student and exhibitioner in the University of Dublin, where he was gold medalist in mathematics and physical science, and obtained the mathematical studentship of 1900, besides other prizes and distinctions. In 1896 he was appointed demonstrator in physics at the Cavendish Laboratory at Cambridge. He was Clerk-Maxwell scholar in 1899, and was elected to a fellowship at Trinity in the same year. The subjects of this chair, of which the income is provided from the revenues of New College, are electricity and magnetism, which are thus withdrawn from the province of the professor of experimental philosophy, by whom they have hitherto been taught. Merten College has contributed £700 towards fitting up, and £500 towards the maintenance of, a new electrical laboratory for the use of the professor.

IT is announced that Sir William Muir, who is now 81 years of age, will shortly retire from the presidency of the University of Edinburgh.